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**Pereira et al.**

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(54) **INFORMATION GAUGE WITH ANALOG BACKUP**

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15, 2013.

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**G08B 21/00** (2006.01)  
**G08B 5/22** (2006.01)  
**G08B 5/06** (2006.01)

(52) **U.S. Cl.**  
CPC ... **G08B 5/22** (2013.01); **G08B 5/06** (2013.01)

(58) **Field of Classification Search**  
CPC ..... G08B 5/00  
USPC ..... 340/815.69, 626, 540; 73/1.57, 700,  
73/749

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,404,842 A 9/1983 Mooney  
6,822,565 B2 11/2004 Thomas et al.

(Continued)

FOREIGN PATENT DOCUMENTS

EP 2339222 6/2011

OTHER PUBLICATIONS

International Search Report dated Dec. 17, 2014 and Written Opinion  
of the International Searching Authority dated Dec. 17, 2014 for PCT  
International Application No. PCT/US2014/051282, filed Aug. 15,  
2014, PCT International Application No, PCT/US2014/051282 cor-  
responds to and claims priority from U.S. Appl. No. 61/866,091, filed  
Aug. 15, 2013. (10 pages)

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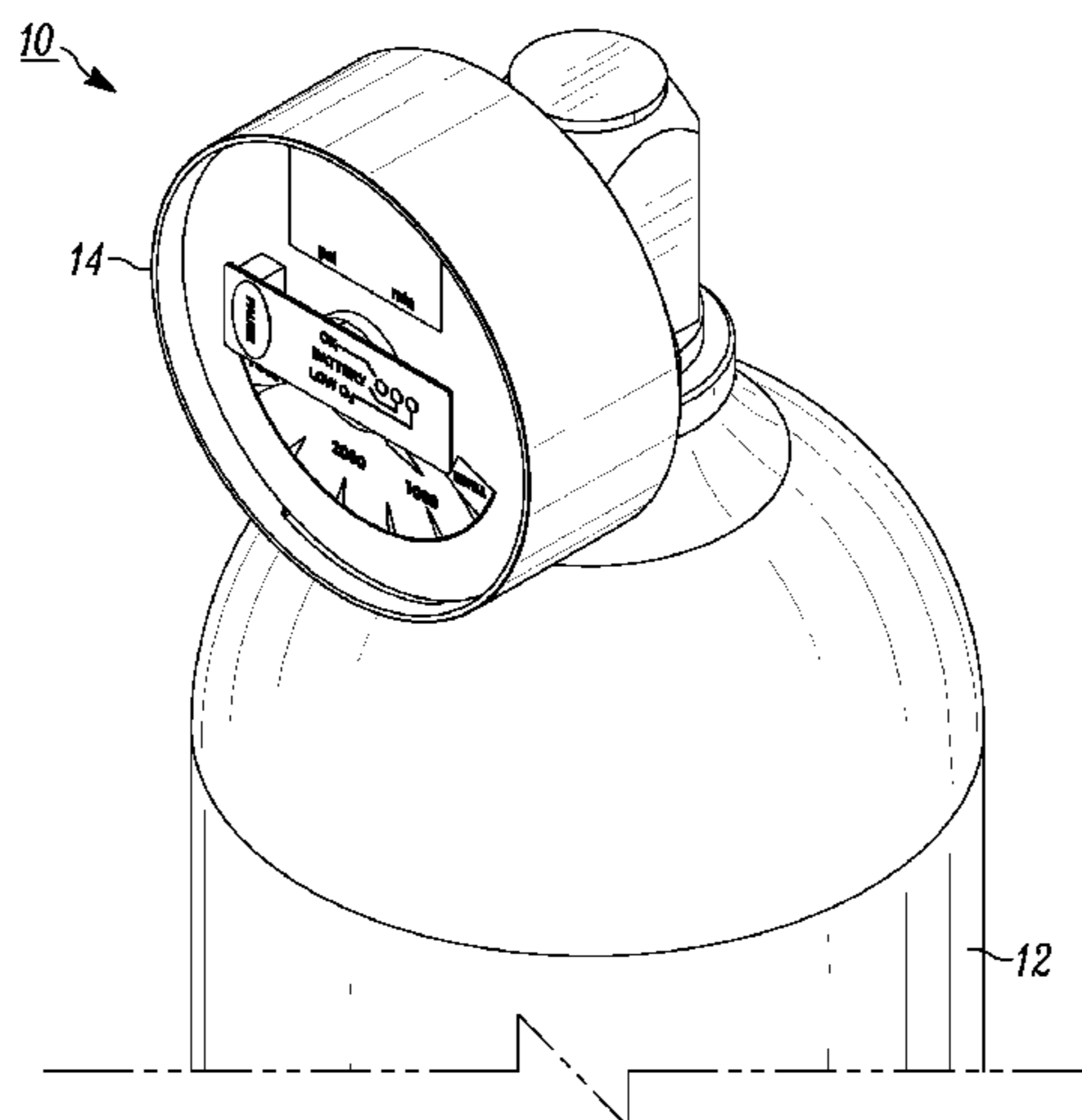
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(57) **ABSTRACT**

An information gauge apparatus and method for providing  
both visual and audio readings of pressure within a pressure  
vessel. The information gauge apparatus includes a digital  
display coupled to a printed circuit board in communication  
with a pressure sensor. The digital display illustrates indicia  
relating gas pressure levels provided by the pressure sensor to  
the printed circuit board during use. The gauge further com-  
prises an audible indicator coupled to the printed circuit  
board, the audible indicator provides an audible signal relat-  
ing to gas pressure levels sensed by the pressure sensor to the  
printed circuit board during use. The gauge also includes a  
mechanical sensor providing a mechanically sensed reading  
value to a visual indicia display on the information gauge  
apparatus relating to gas pressure levels during use.

**22 Claims, 13 Drawing Sheets**



(56)

**References Cited**

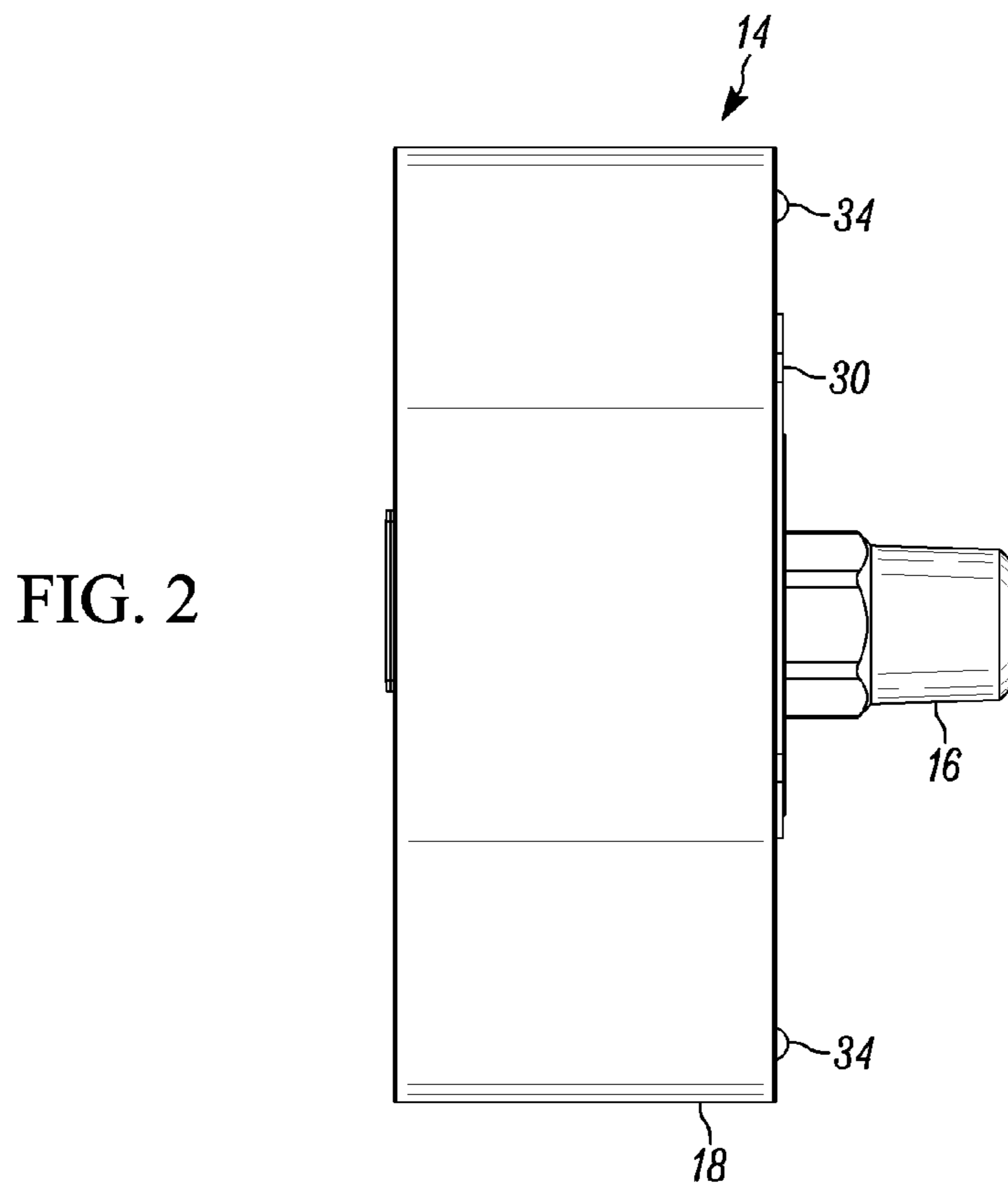
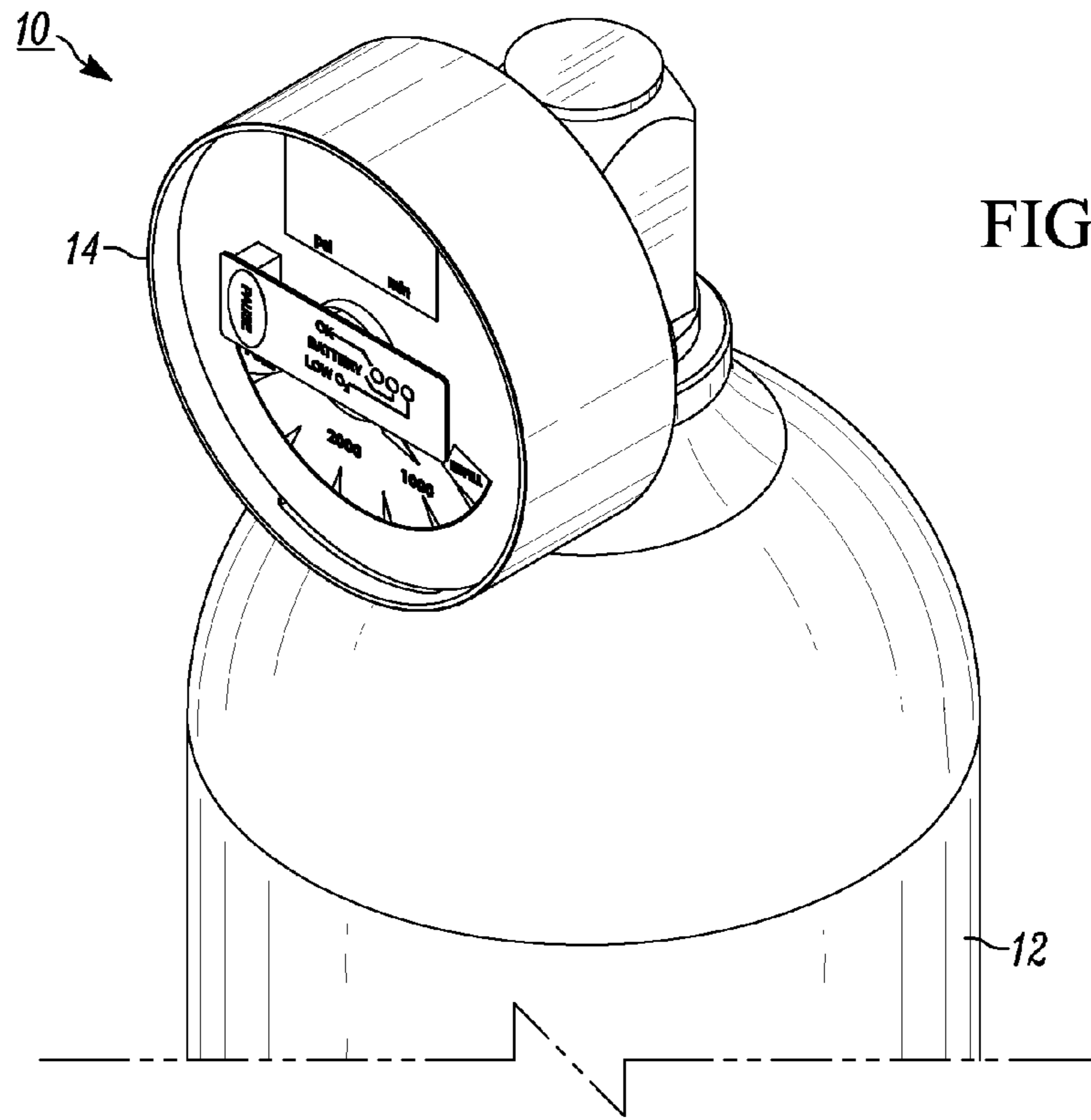
U.S. PATENT DOCUMENTS

7,891,250 B2 2/2011 Parias  
8,047,079 B2 11/2011 Bleys et al.  
8,400,288 B2 3/2013 Bowden et al.

2006/0144159 A1 7/2006 Weiss  
2010/0024517 A1 2/2010 Ratner

OTHER PUBLICATIONS

2 page Liquid Air Advertisement that was on sale more than one year prior to the filing date of this application, namely Aug. 14, 2012.



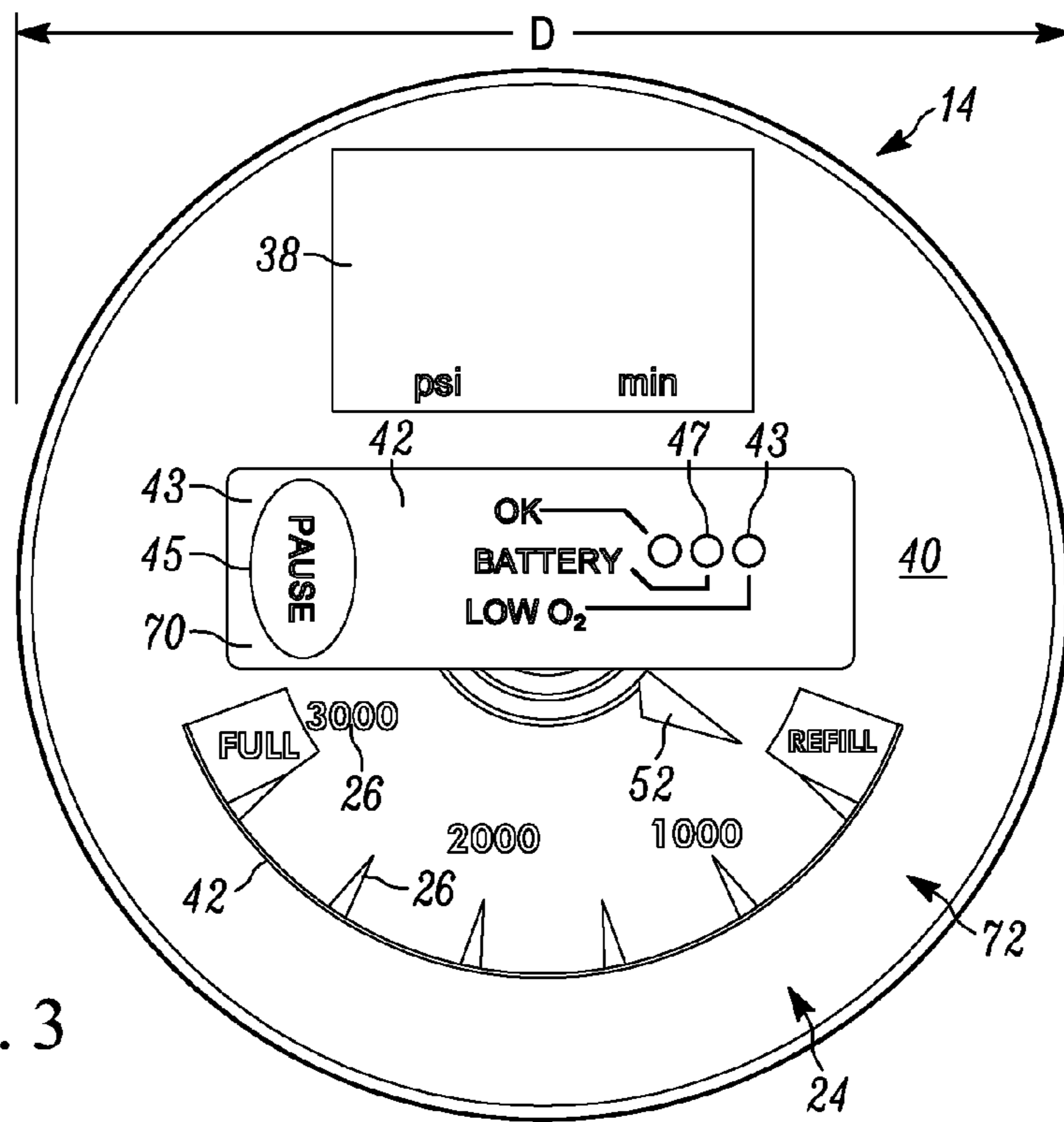
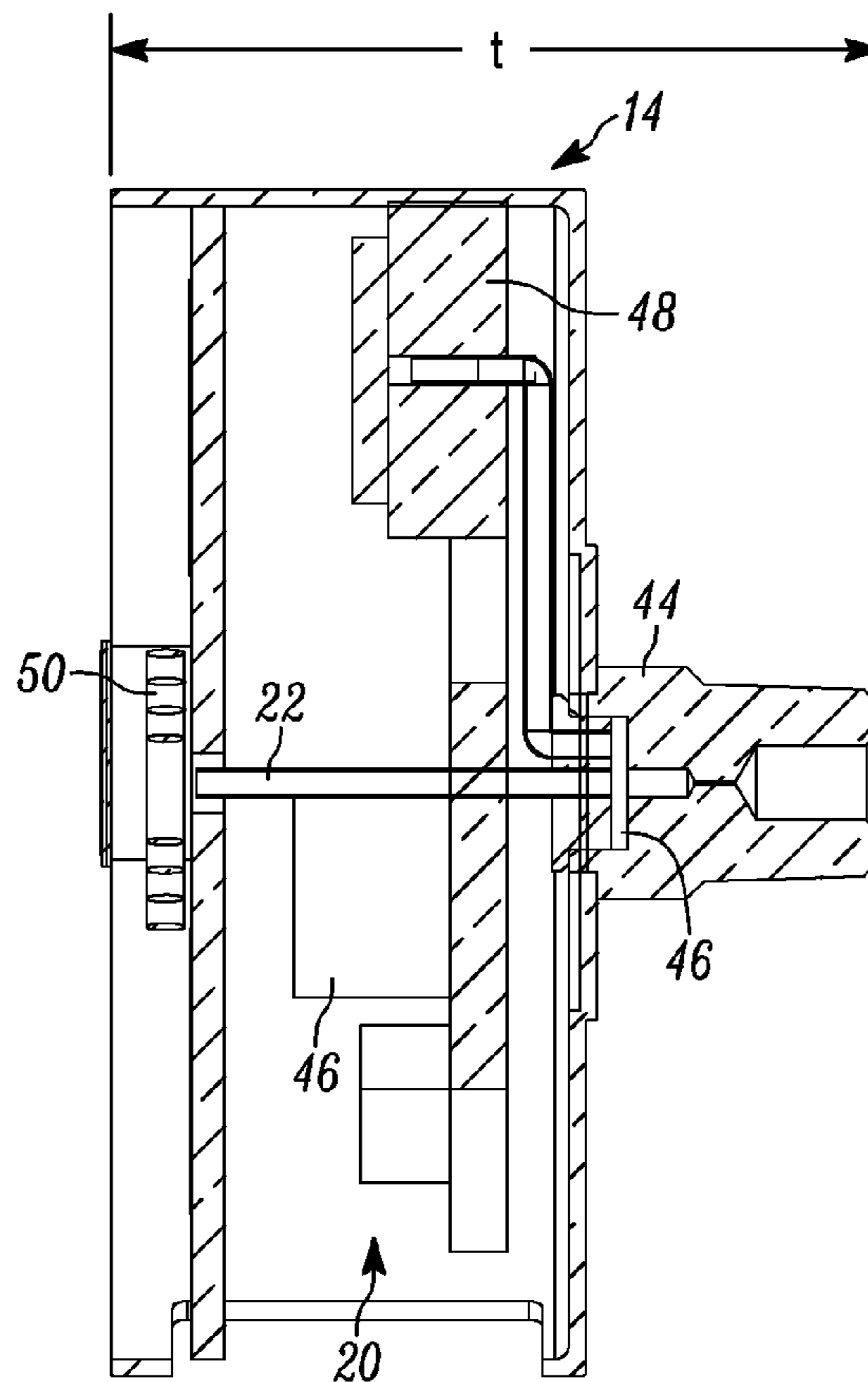


FIG. 4



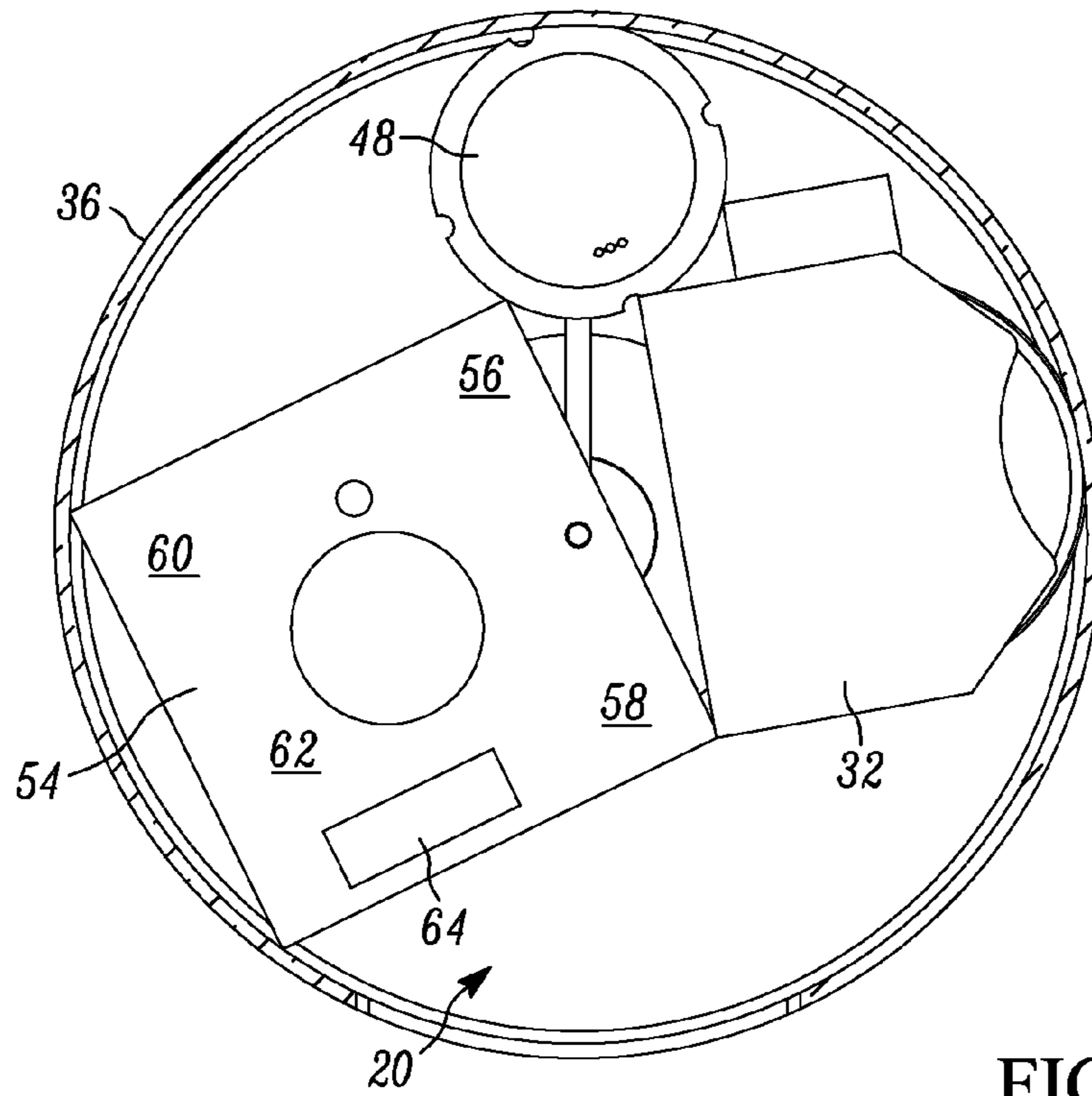


FIG. 5

FIG. 7 ←

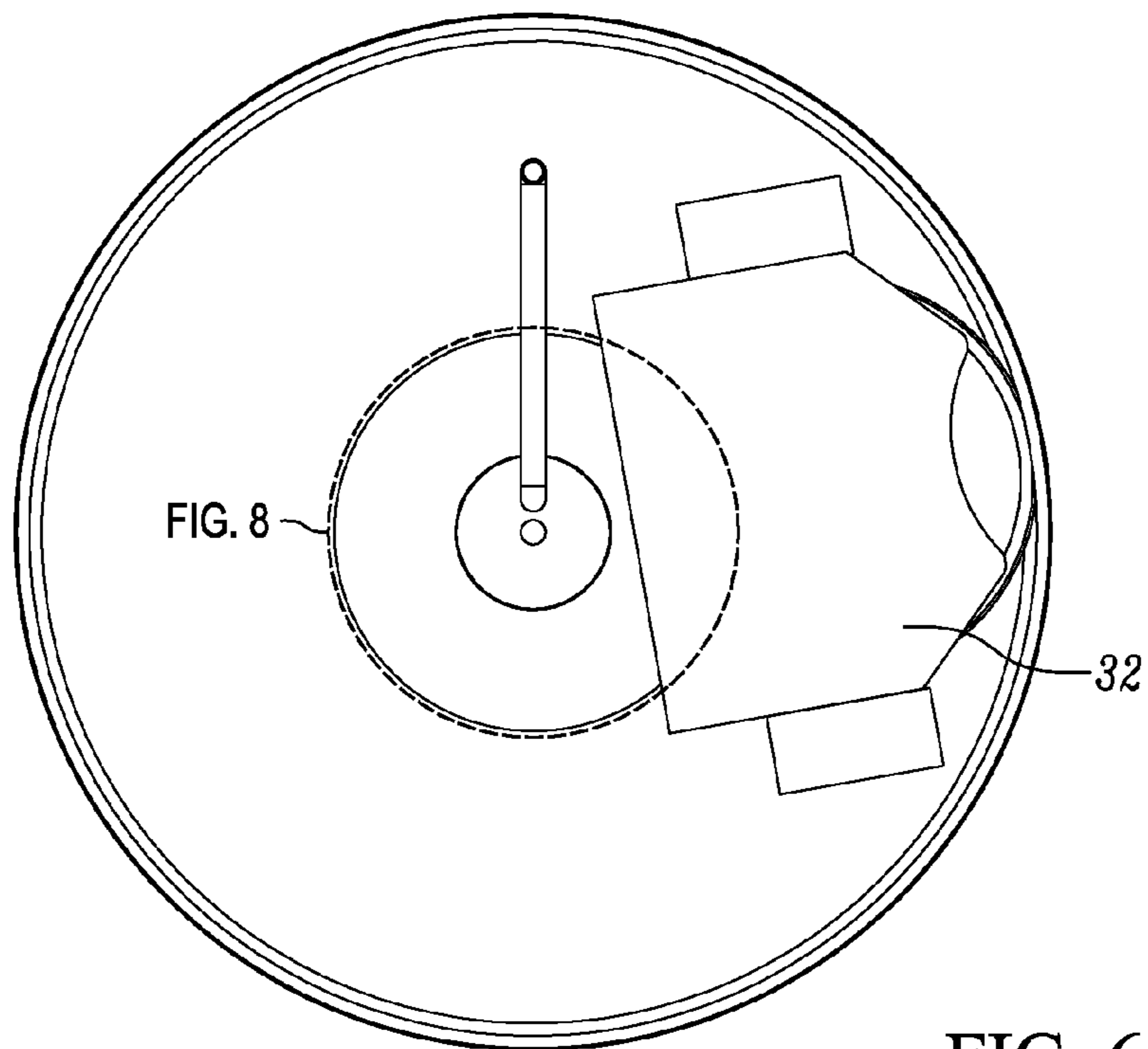


FIG. 6

FIG. 7 ←

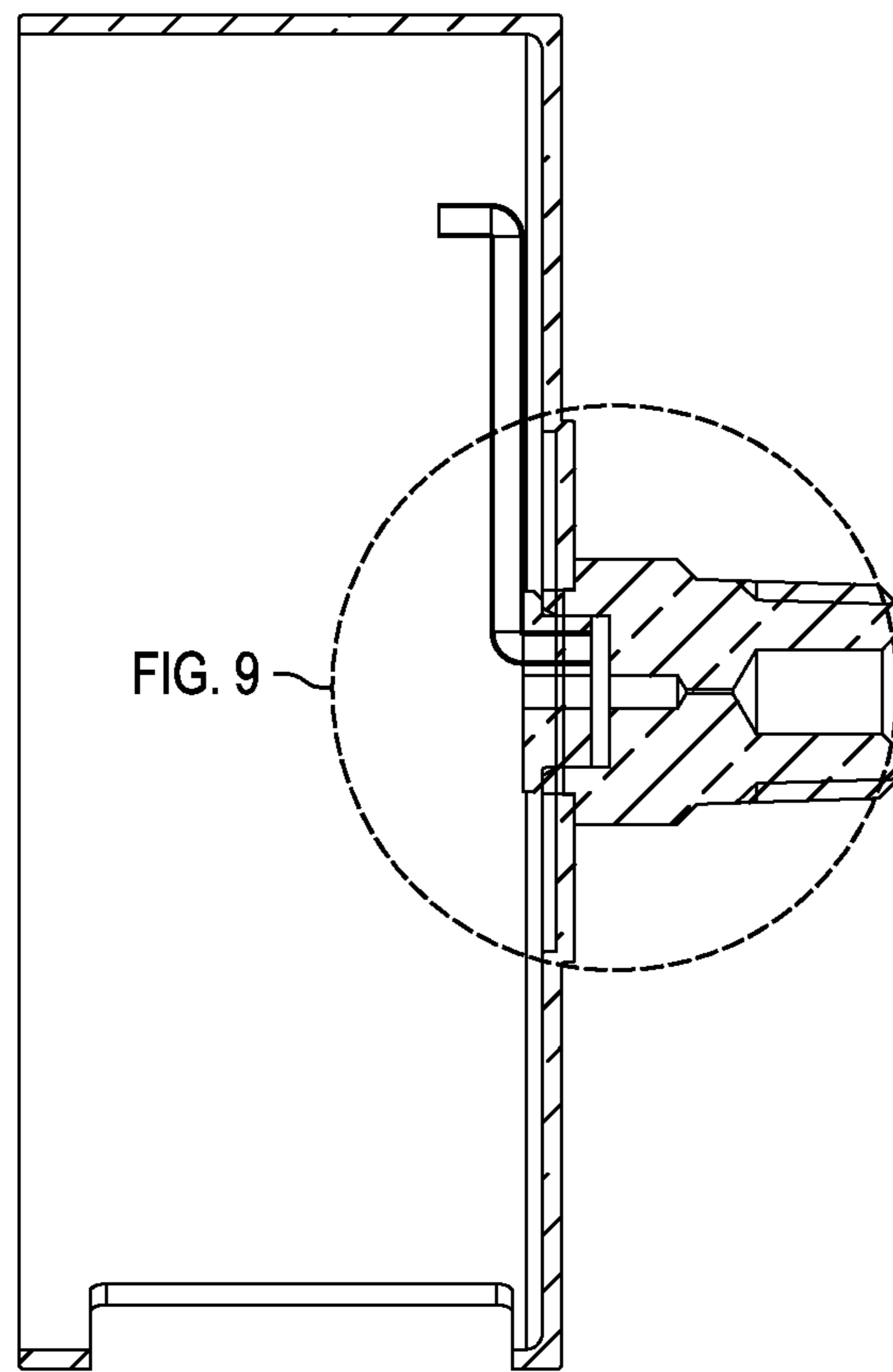


FIG. 7

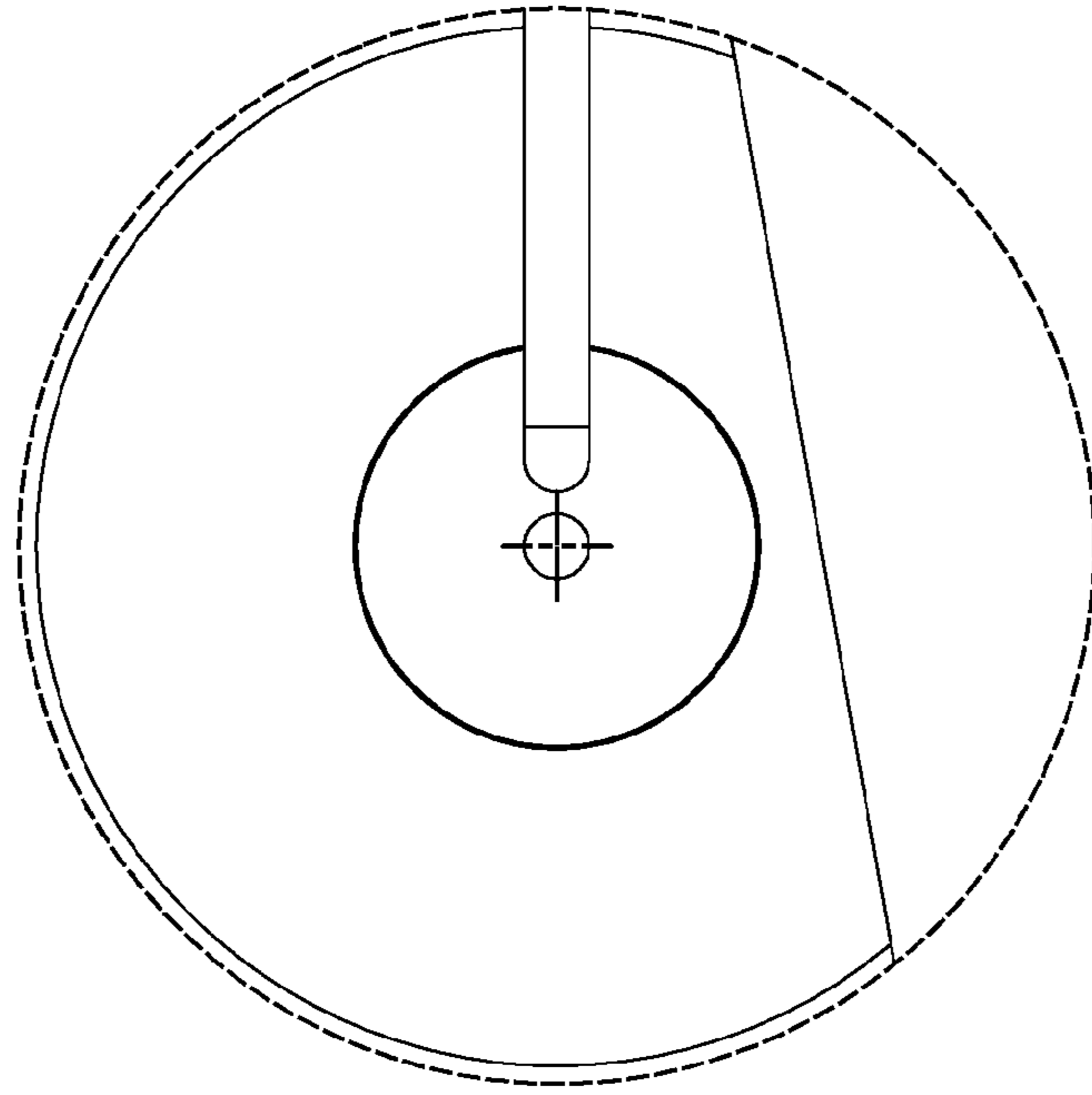


FIG. 8

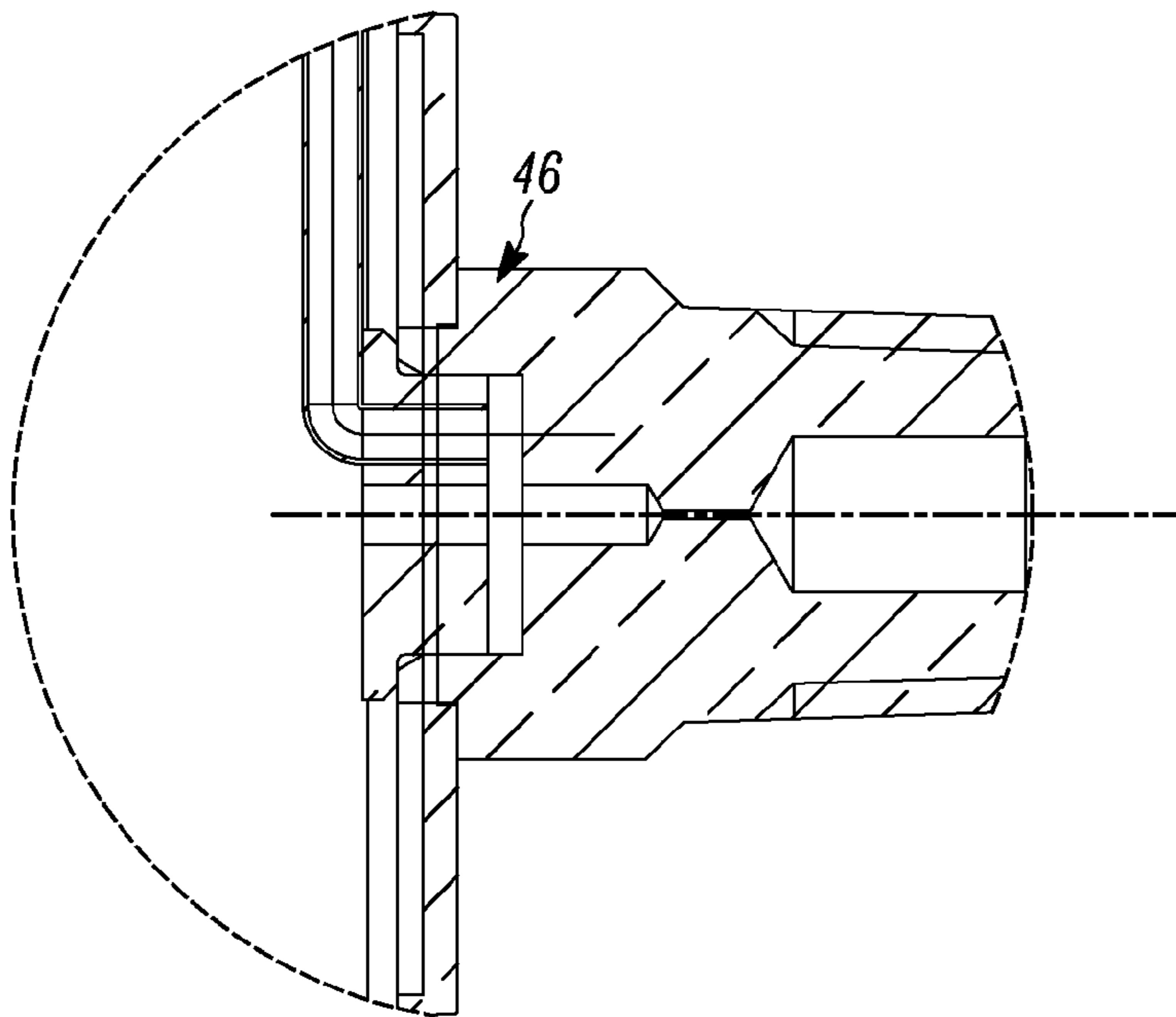


FIG. 9

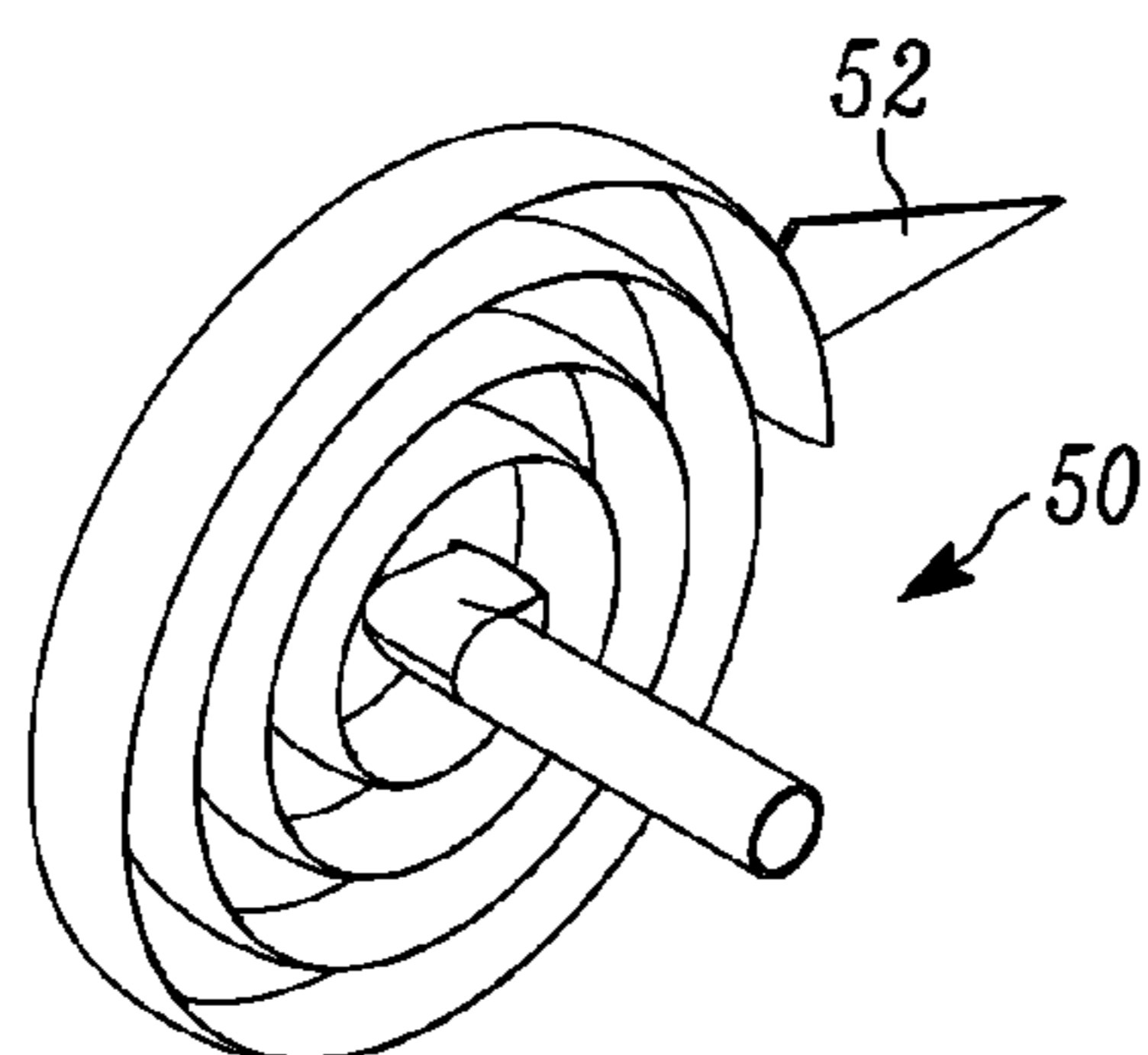


FIG. 10

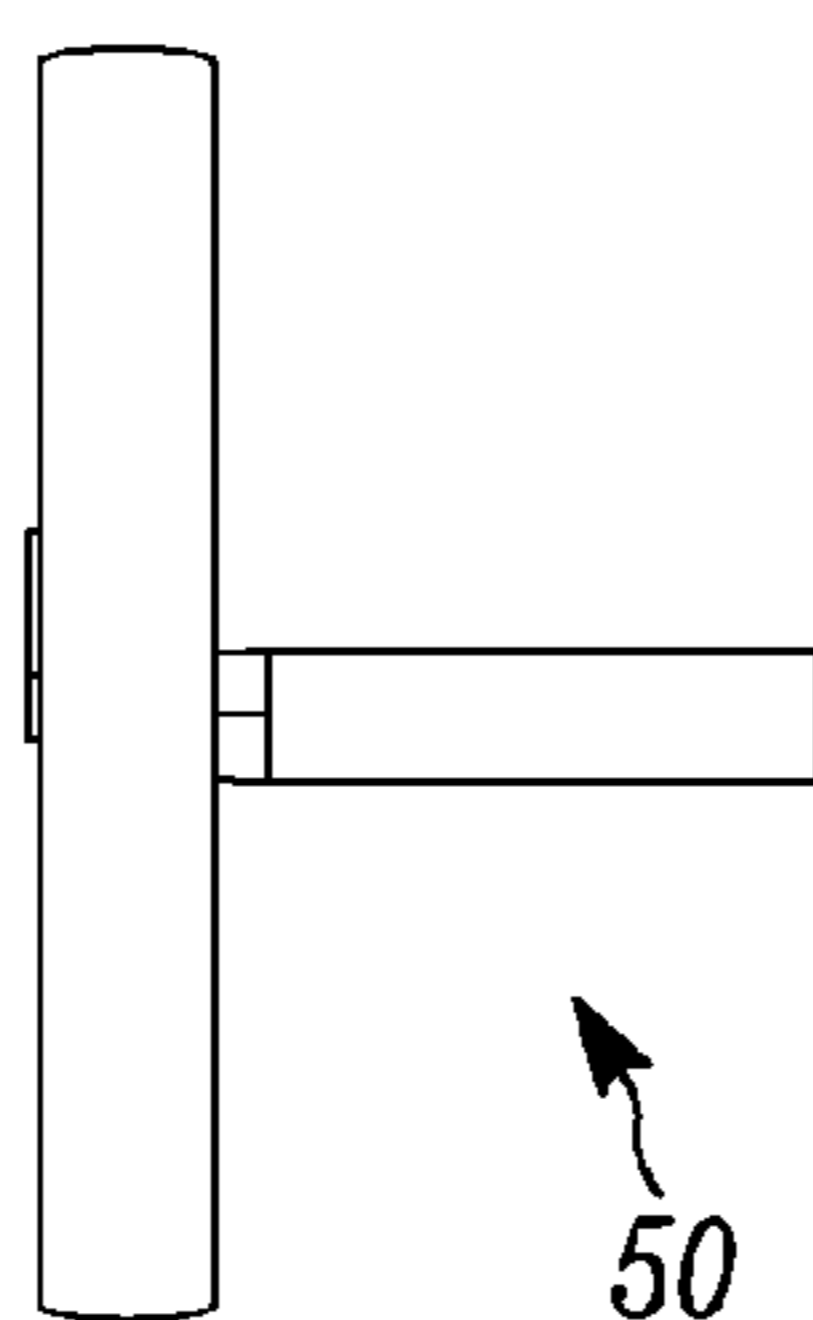


FIG. 11

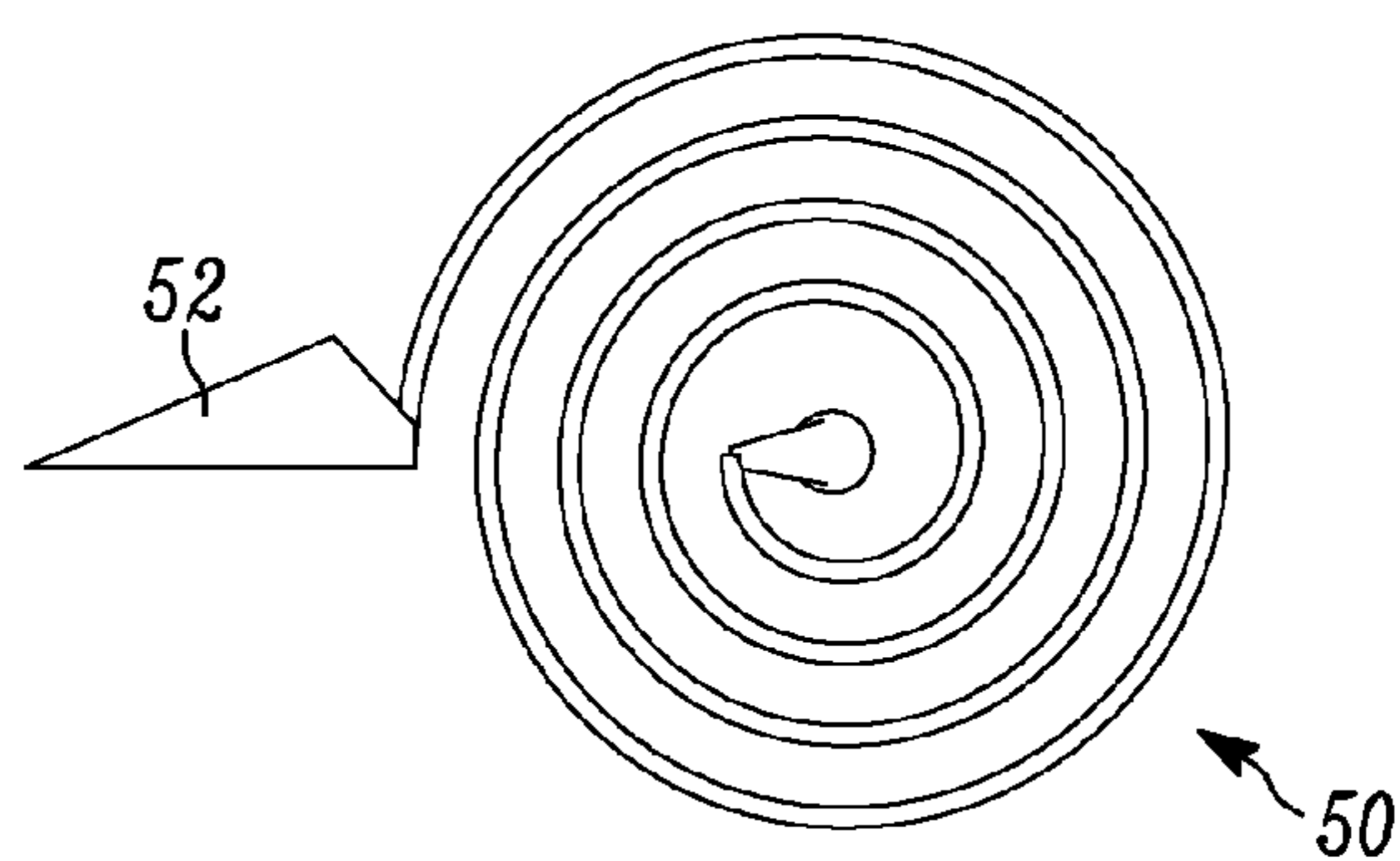


FIG. 12



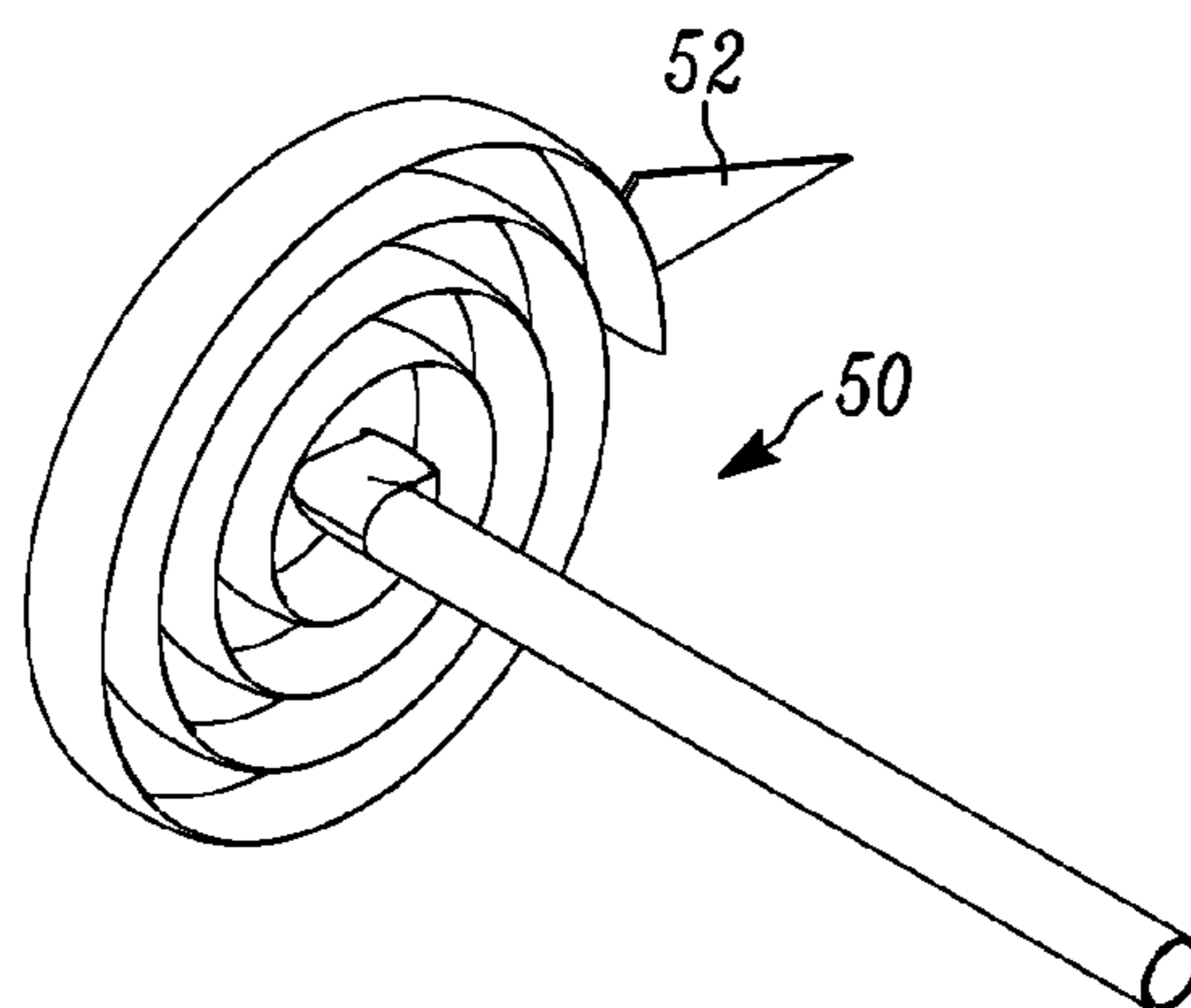


FIG. 13

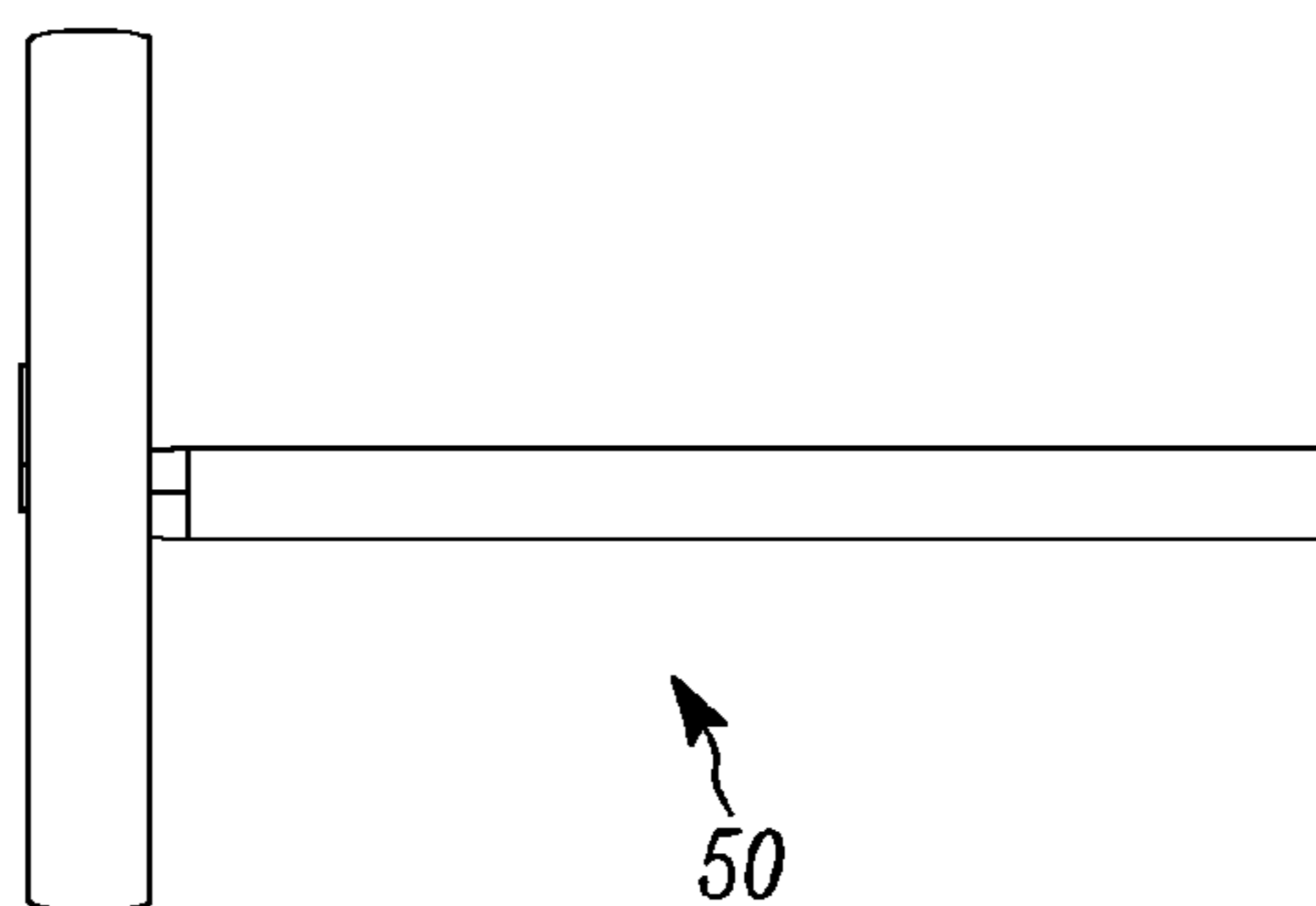


FIG. 14

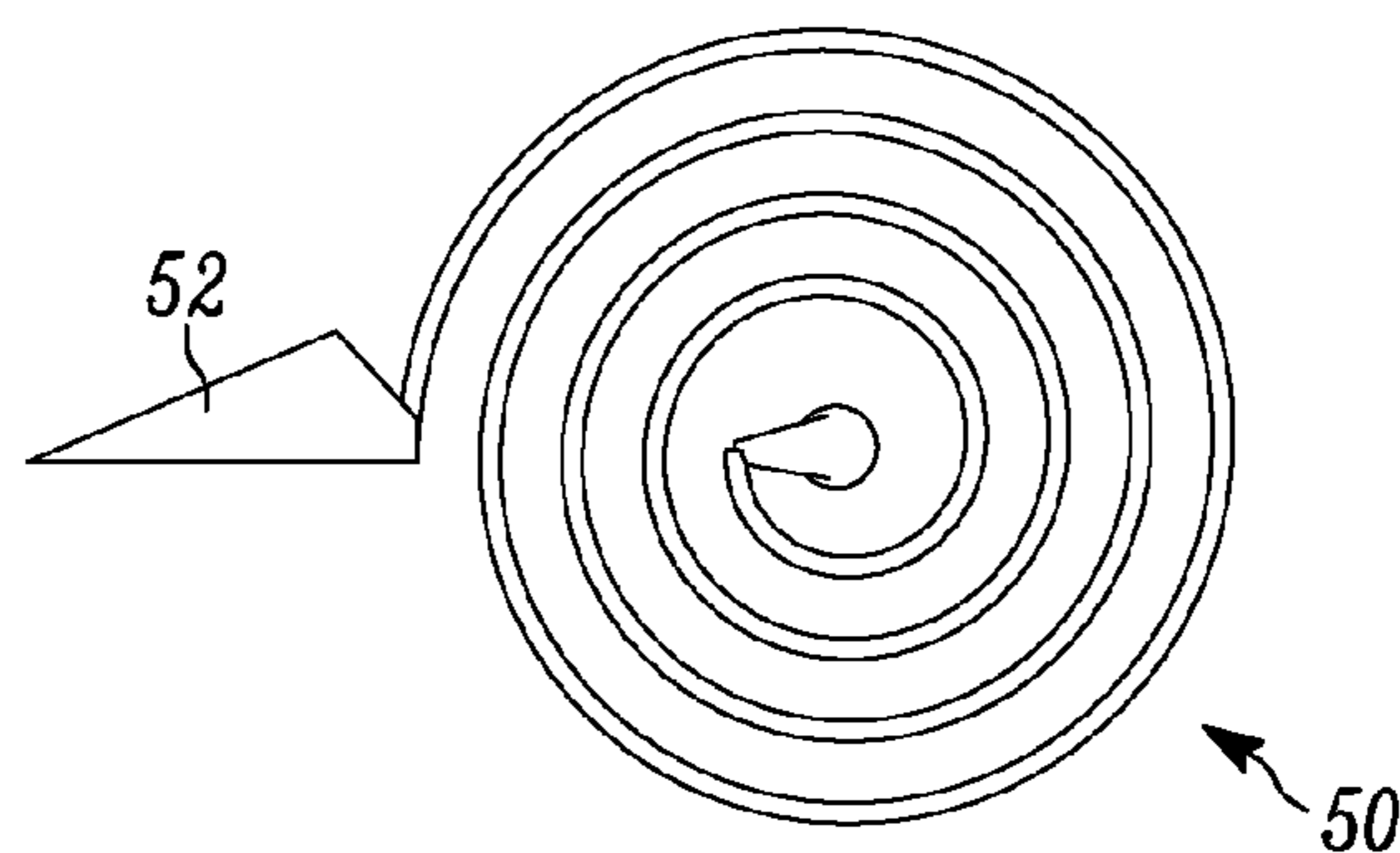


FIG. 15

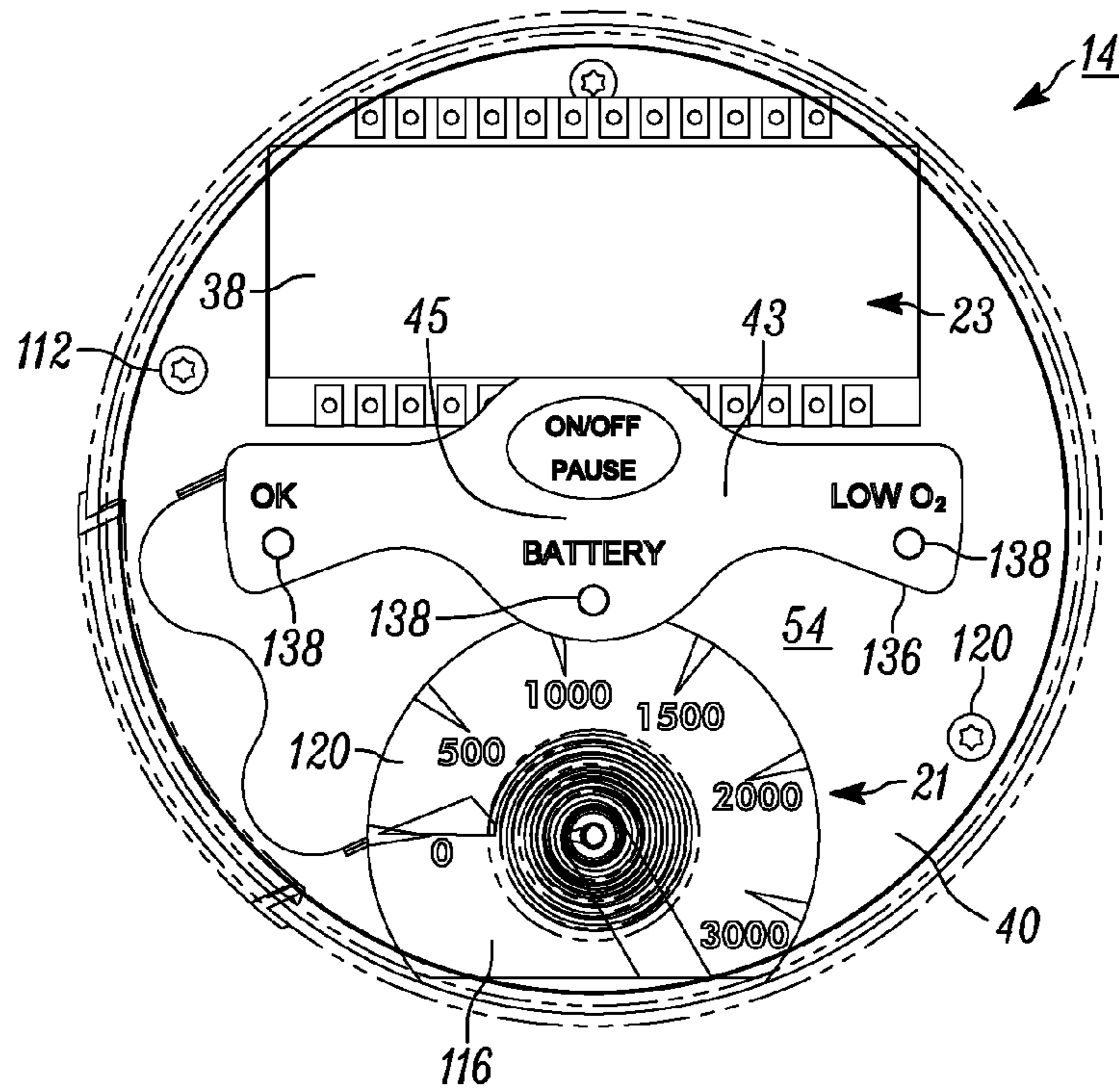


FIG. 16

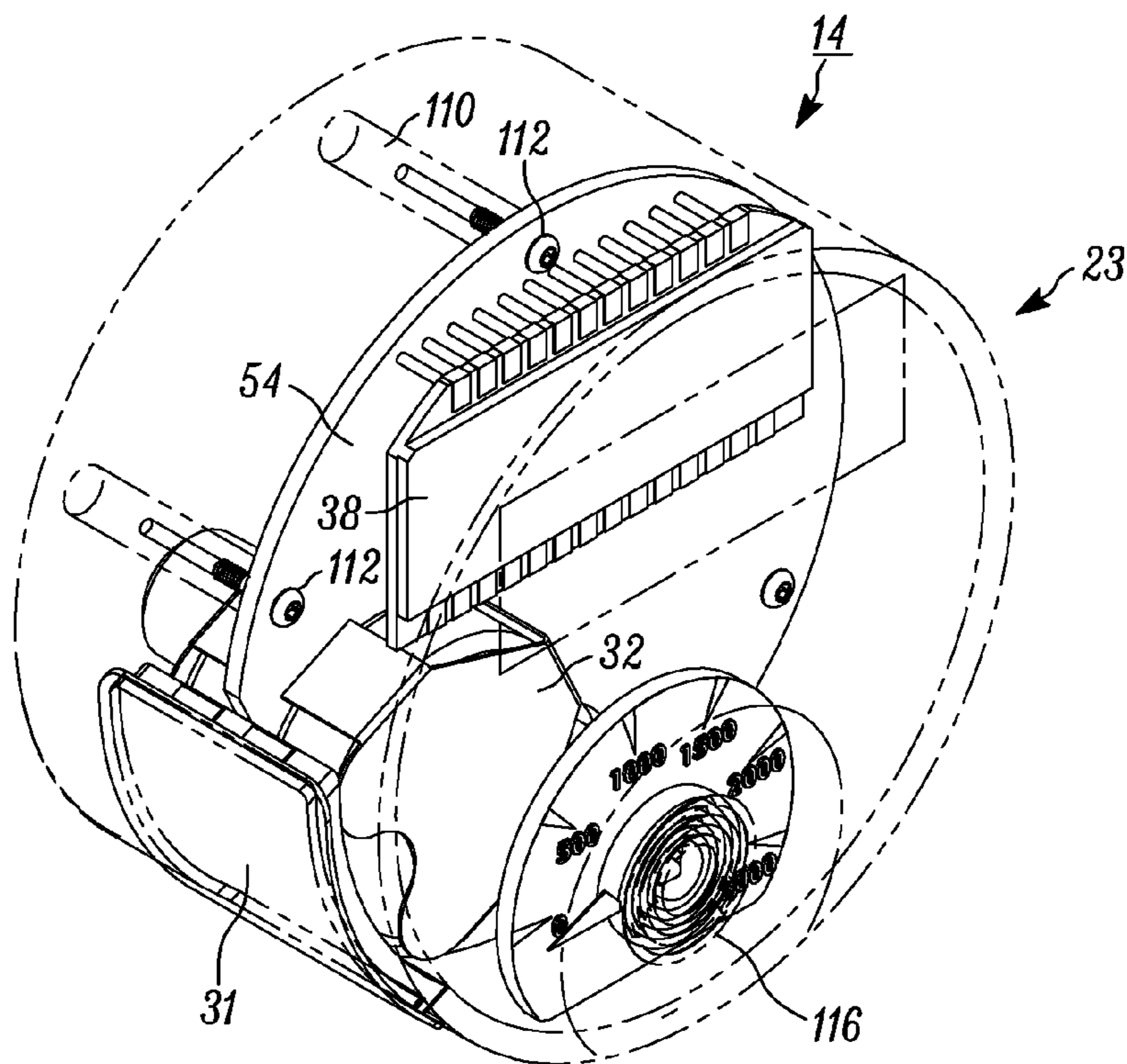


FIG. 17

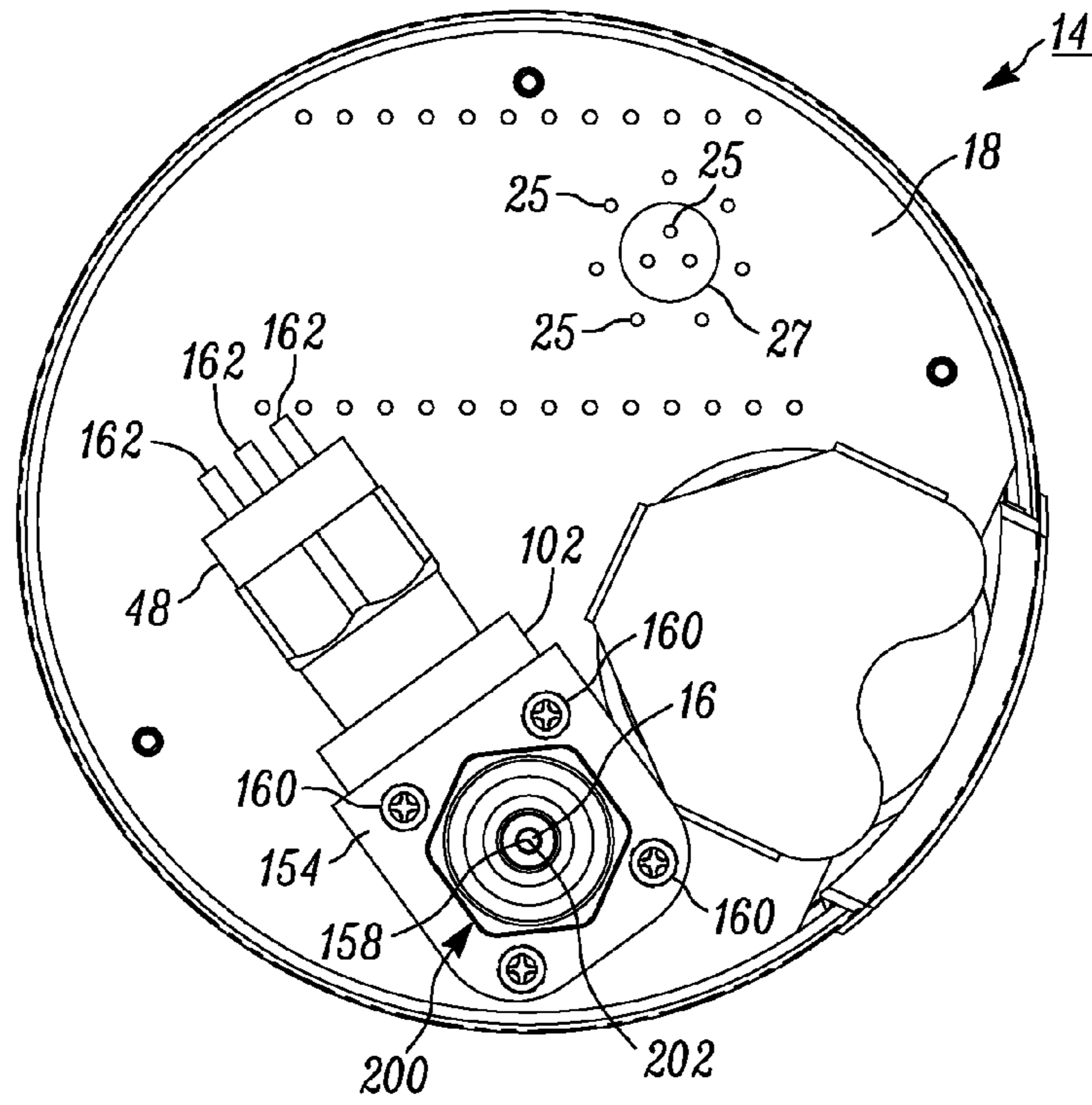


FIG. 18

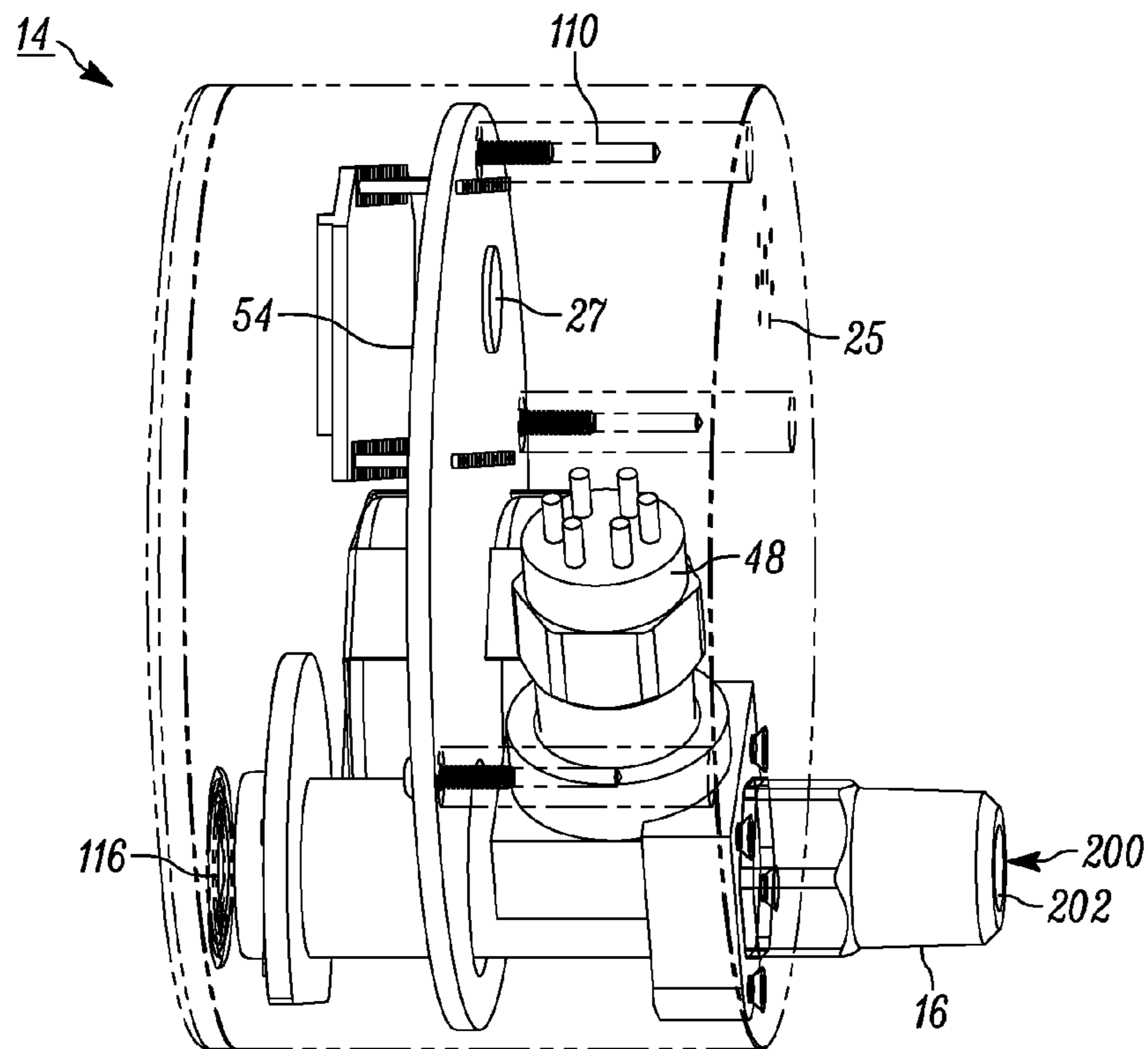


FIG. 19

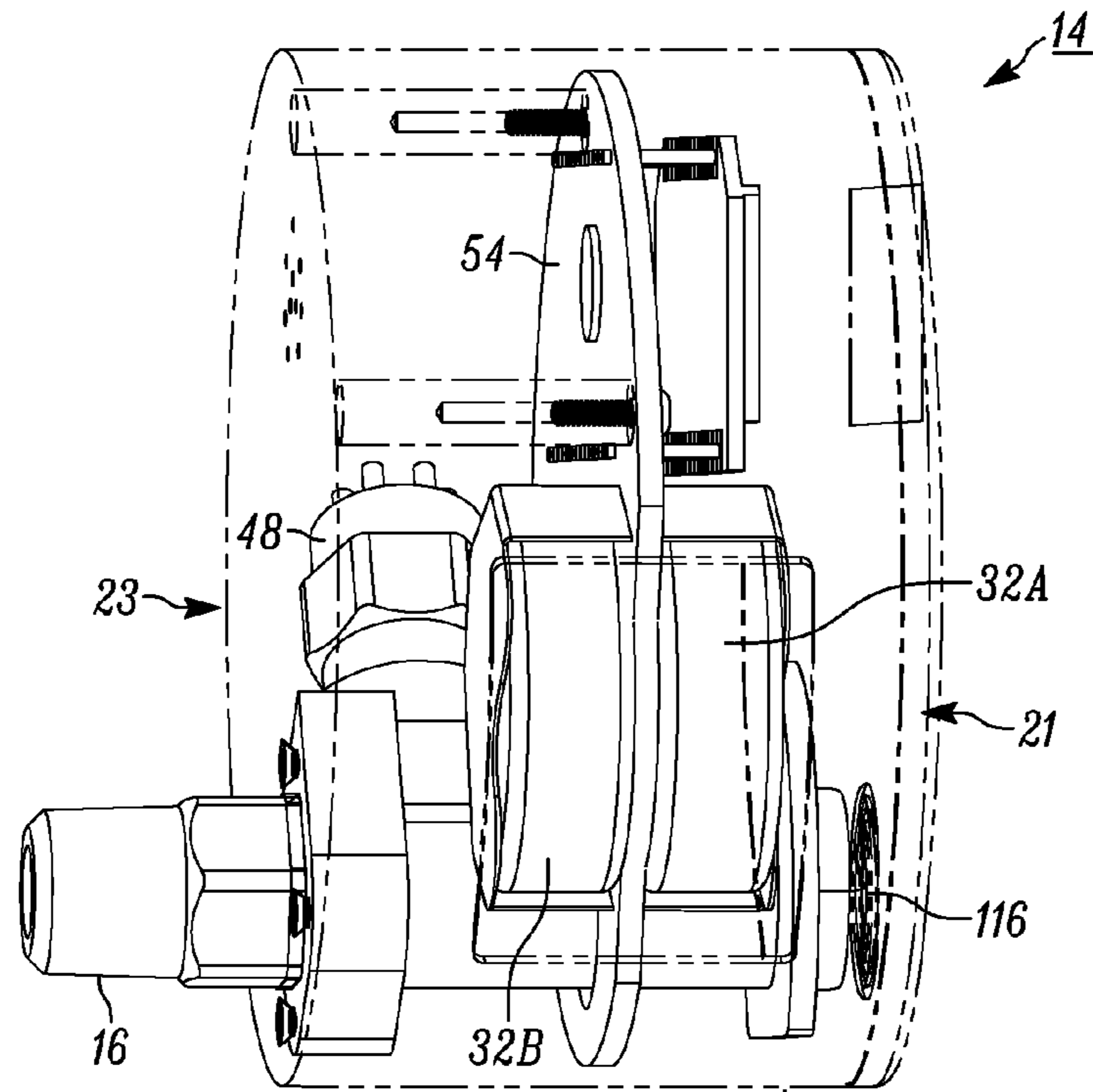


FIG. 20

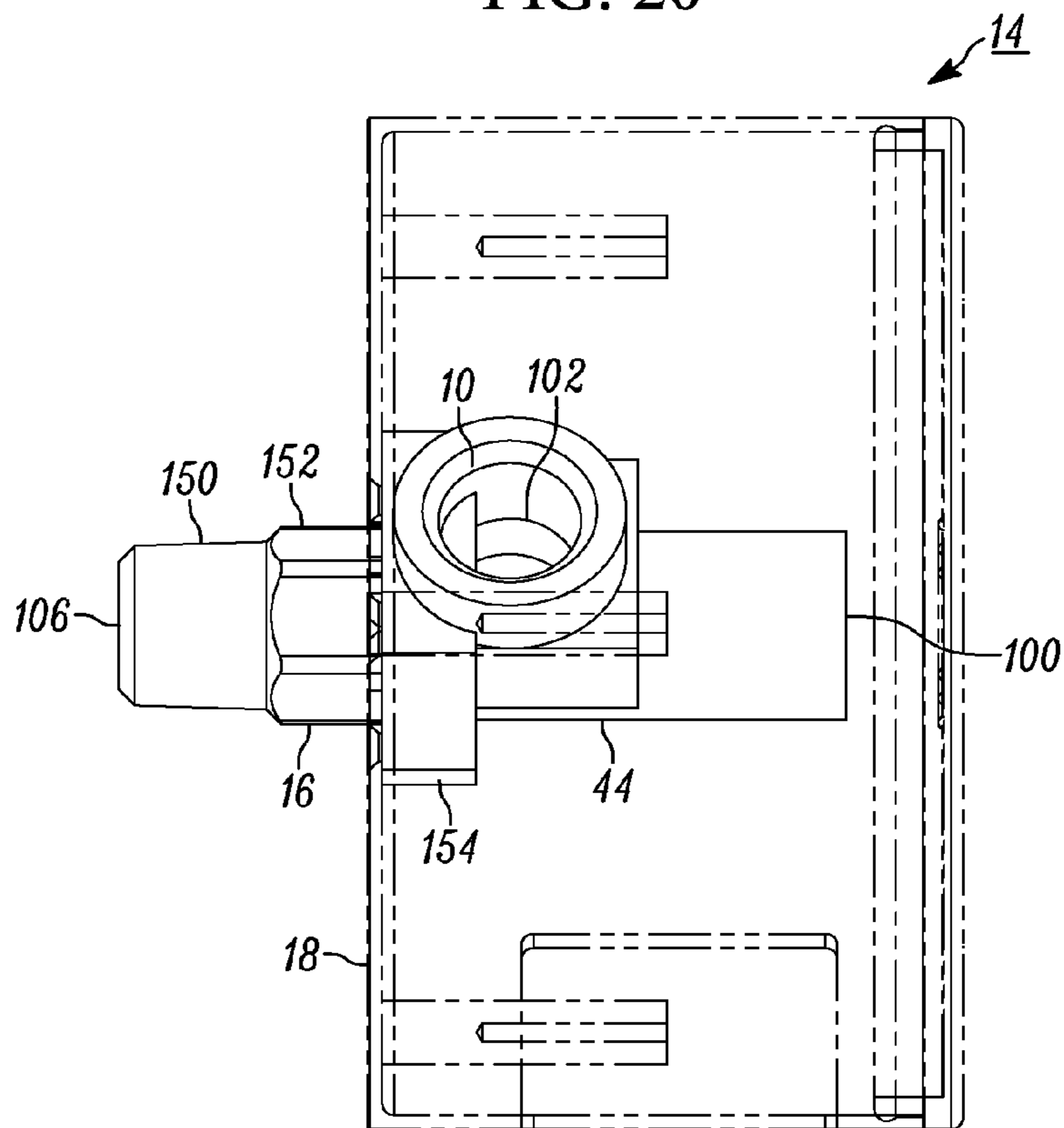


FIG. 21

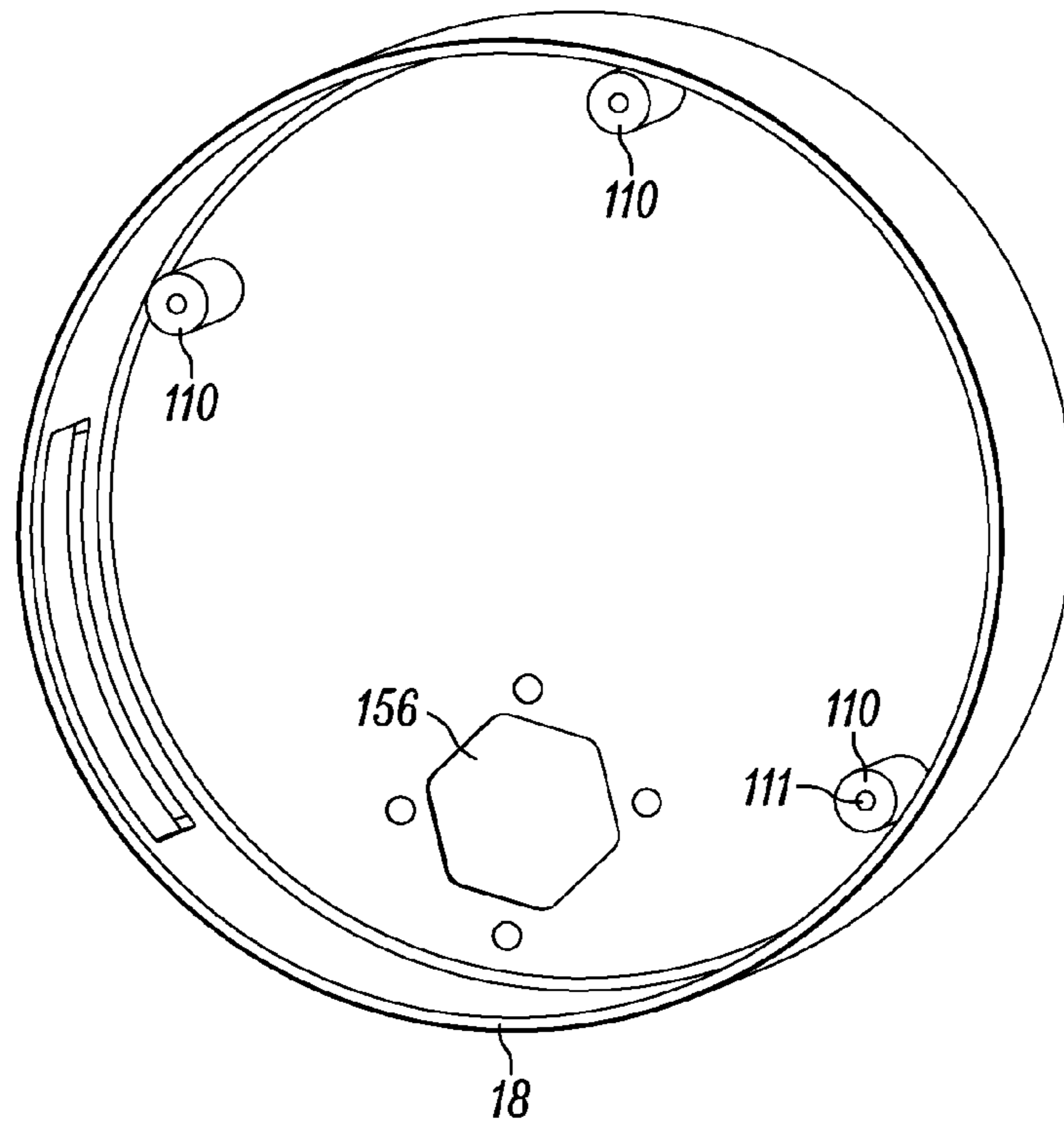


FIG. 22

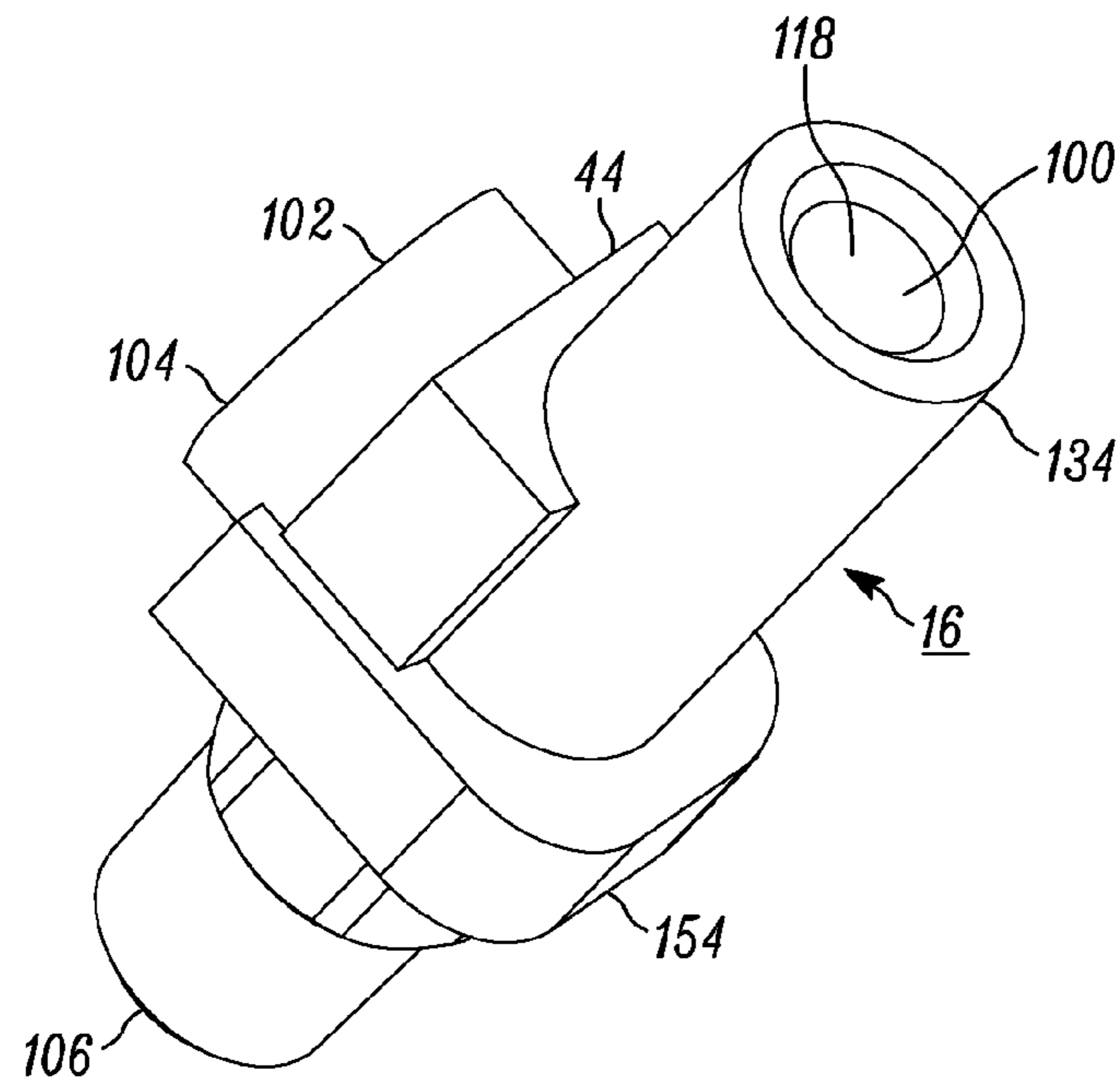


FIG. 23

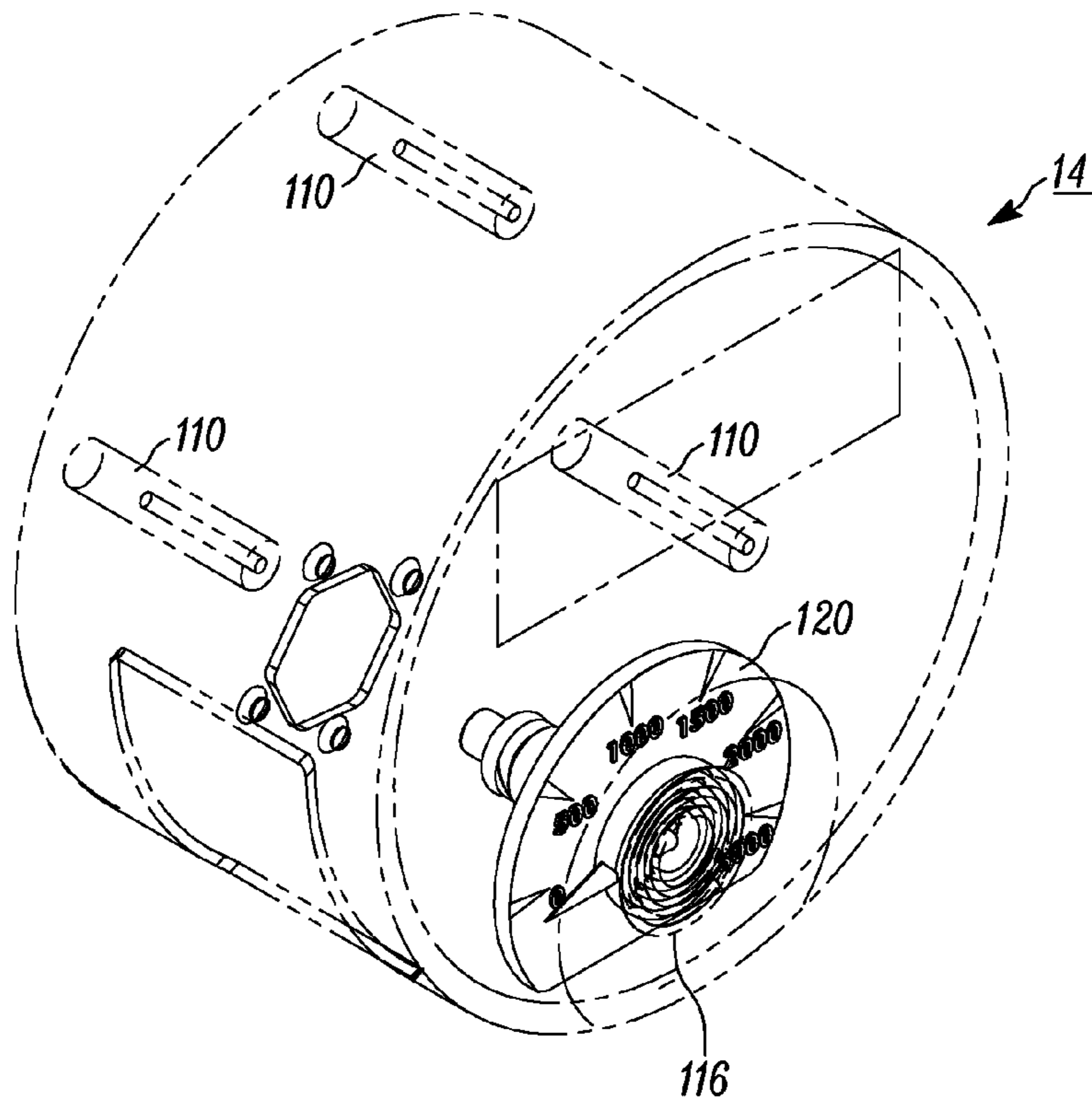


FIG. 24

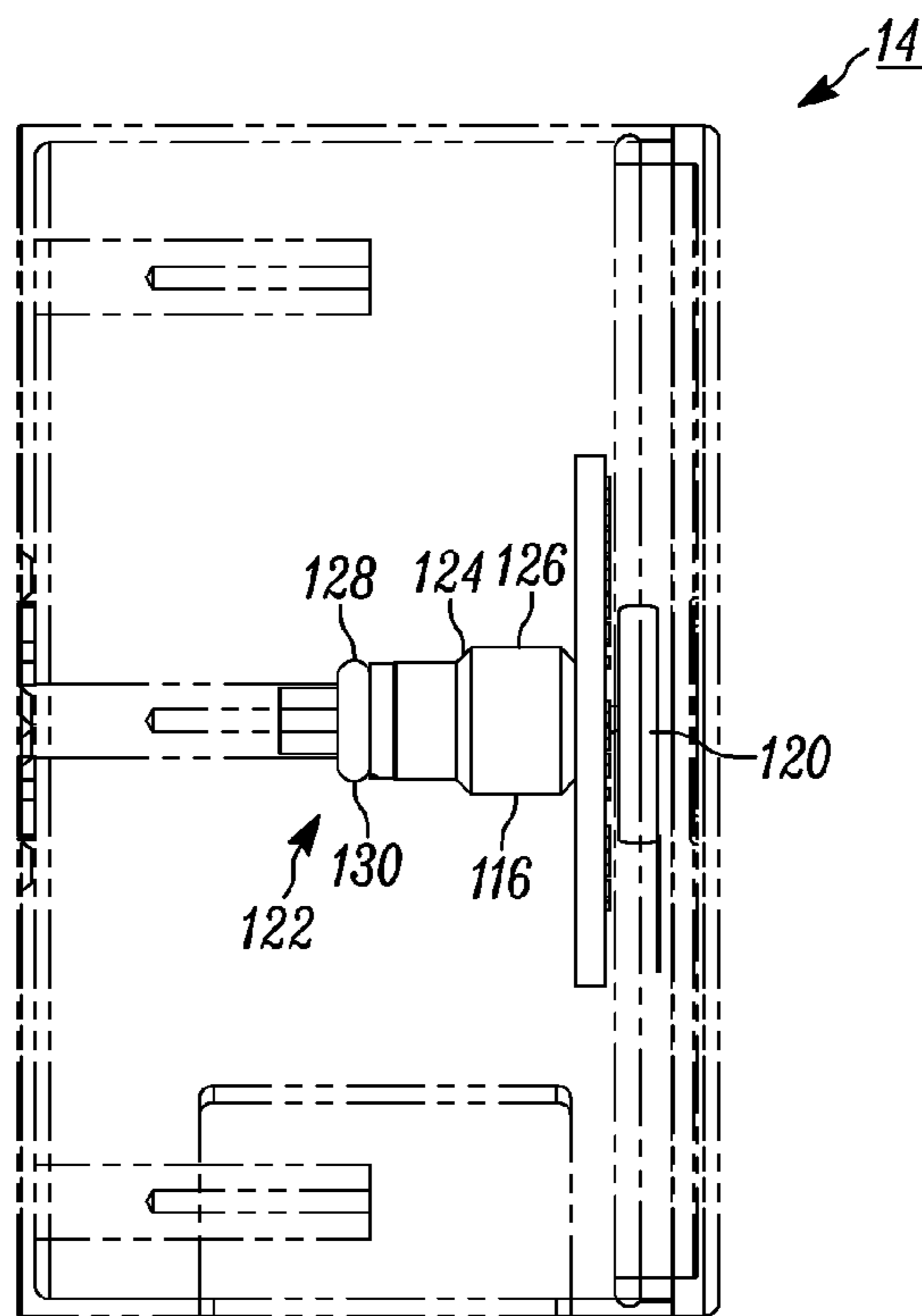


FIG. 25

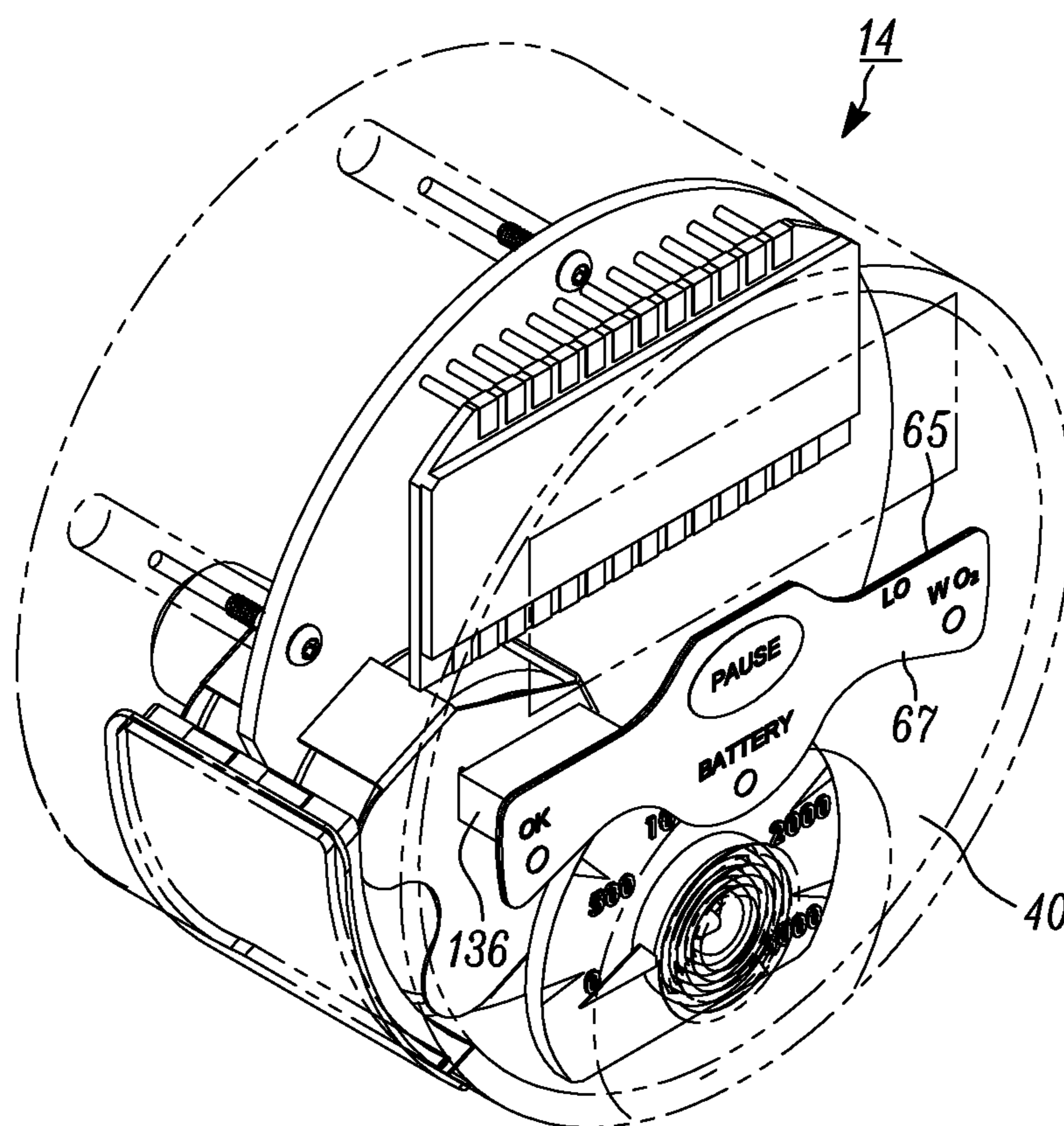


FIG. 26

**1****INFORMATION GAUGE WITH ANALOG  
BACKUP****CROSS REFERENCES TO RELATED  
APPLICATIONS**

The following application claims priority to U.S. Provisional Patent Application Ser. No. 61/866,091 filed Aug. 15, 2013 entitled INFORMATION GAUGE WITH ANALOG BACKUP. The above-identified application is incorporated herein by reference in its entirety for all purposes.

**TECHNICAL FIELD**

The present disclosure relates generally to an information gauge apparatus and method of operation, and more specifically, an information gauge having an analog or mechanical backup to enhance its reliability during use.

**BACKGROUND**

Information gauges are incorporated into devices such as medical gas regulators, industrial gas regulators, valve integrated pressure regulators, manifolds and other assemblies utilizing a regulator for the delivery of gas or fluids (collectively hereinafter “regulators”). Conventional information gauges allow users of regulators often coupled to a pressurized container, such as pressurized cylinders to observe the amount of pressure gas that remains within the container. Such information is essential for patients and the medical professionals using the containers for medical treatment of the patients.

Medical professionals in their concern that a patient may run out of gas or oxygen often results in a return of pressurized cylinders still having ample unused oxygen. Pressurized container industry veterans typically observe about 30% of the medical oxygen cylinders being returned with a significant amount of usable gas or product.

**SUMMARY**

One example embodiment of the present disclosure includes an information gauge apparatus and method for providing both visual and audio readings of pressure within a pressure vessel with mechanical redundancy. The information gauge apparatus includes a digital display coupled to a printed circuit board in communication with a pressure sensor. The digital display illustrates indicia relating gas pressure levels provided by the pressure sensor to the printed circuit board during use. The gauge further comprises an audible indicator coupled to the printed circuit board, the audible indicator provides an audible signal relating to gas pressure levels sensed by the pressure sensor to the printed circuit board during use. The gauge also includes a mechanical sensor providing a mechanically sensed reading value to a visual indicia display on the information gauge apparatus relating to gas pressure levels during use.

Another example embodiment of the present disclosure includes an information gauge apparatus for displaying information relating to diagnostics when the information gauge apparatus is coupled to a pressure vessel, the apparatus comprises: a digital gauge having a digital display, printed circuit board, and pressure sensor, the digital display being coupled to and in communication with the printed circuit board that is further coupled to and in communication with the pressure sensor, the digital display illustrating pressure conditions relating a pressure vessel when in use; a mechanical gauge

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providing a mechanically sensed pressure conditions relating to a pressure vessel when in use; a casing for supporting the mechanical gauge and the digital gauge having a back plate and a front plate; and an input duct for coupling the digital gauge and the mechanical gauge to a pressure vessel during use, the input duct having a single orifice for coupling to a pressure vessel, the single orifice having a pathway that is divided between a first fluid communication channel for coupling to the mechanical gauge and a second fluid communication channel for coupling to the digital gauge.

While another example embodiment of the present disclosure includes an information gauge apparatus for providing both visual and audio readings of pressure within a pressure vessel, the information gauge apparatus comprising: a digital display coupled to a printed circuit board in communication with a pressure sensor, the digital display illustrating indicia relating gas pressure levels provided by the pressure sensor to the printed circuit board during use; an audible indicator coupled to the printed circuit board, the audible indicator providing an audible signal relating to gas pressure levels provided by the pressure sensor to the printed circuit board during use; and a mechanical sensor providing a mechanically sensed reading value to a visual indicia display on the information gauge apparatus relating to gas pressure levels during use.

Yet another example embodiment of the present disclosure comprises a digital audio visual information gauge with a mechanical pressure indicating backup, the gauge comprising: a casing that provides a housing for a mechanical system and an electrical system, the electrical system is capable of indicating time and pressure remaining in a cylinder valve assembly during use and the mechanical system being capable of indicate pressure remaining in the same cylinder valve during use; an input duct that is rigidly connected to the casing, the input duct having a single orifice for connecting to a cylinder valve at a first end of the input duct and first and second fluid communication channels at a second end of the input duct, the first and second fluid communication channels being in communication with the single orifice, the first fluid communication channel for coupling to the mechanical system and the second communication channel for coupling to the electrical system.

**BRIEF DESCRIPTION OF THE DRAWINGS**

The foregoing and other features and advantages of the present disclosure will become apparent to one skilled in the art to which the present disclosure relates upon consideration of the following description of the invention with reference to the accompanying drawings, wherein like reference numerals, unless otherwise described refer to like parts throughout the drawings and in which:

FIG. 1 is a perspective view of a pressure assembly having an information gauge apparatus and pressure vessel constructed in accordance with one example embodiment of the present disclosure;

FIG. 2 is a side elevation view of an information gauge apparatus constructed in accordance with one example embodiment of the present disclosure;

FIG. 3 is a front elevation view of FIG. 2;

FIG. 4 is a section view of FIG. 3 along section lines A-A;

FIG. 5 is a section view of FIG. 4 along section lines B-B, illustrating the location of a circuit board, pressure sensor, and auxiliary power supply;

FIG. 6 is another section view of FIG. 4 along section lines B-B without the pressure sensor and circuit board illustrated in FIG. 5;



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FIG. 7 is a section view of FIG. 6 along section lines B-B;  
 FIG. 8 is a magnified view of area A illustrated in FIG. 6;  
 FIG. 9 is a magnified view of area C illustrated in FIG. 7;  
 FIG. 10 is a perspective view of a mechanical backup  
 constructed in accordance with one example embodiment of  
 the present disclosure;

FIG. 11 is a side elevation view of FIG. 10;

FIG. 12 is a front elevation of FIG. 10;

FIG. 13 is a perspective view of a mechanical backup  
 constructed in accordance with one example embodiment of  
 the present disclosure;

FIG. 14 is a side elevation view of FIG. 13;

FIG. 15 is a front elevation of FIG. 13;

FIG. 16 is a front elevation of a pressure assembly con-  
 structed in accordance with another example embodiment of  
 the present disclosure;

FIG. 17 is a perspective assembly view of the pressure  
 assembly of FIG. 16;

FIG. 18 is a rear elevation view of the pressure assembly of  
 FIG. 16;

FIG. 19 is a first-side elevation assembly view of the pres-  
 sure assembly of FIG. 16;

FIG. 20 is a second-side elevation assembly view of the  
 pressure assembly of FIG. 16;

FIG. 21 is a third-side elevation assembly view of the  
 pressure assembly of FIG. 16;

FIG. 22 is a elevation view of a housing constructed in  
 accordance with one example embodiment of the present  
 disclosure;

FIG. 23 is a perspective view of an input duct constructed  
 in accordance with one example embodiment of the present  
 disclosure;

FIG. 24 is a perspective assembly view of a mechanical  
 system as it is located in the gauge assembly in accordance  
 with one example embodiment of the present disclosure;

FIG. 25 is a side elevation view of FIG. 24; and

FIG. 26 is a perspective view of an information gauge  
 apparatus constructed in accordance with another example  
 embodiment of the present disclosure.

#### DETAILED DESCRIPTION

Referring now to the figures wherein like numbered fea-  
 tures shown therein refer to like elements throughout unless  
 otherwise noted. The present disclosure relates generally to  
 an information gauge apparatus and method of operation, and  
 more specifically, an information gauge apparatus having an  
 analog or mechanical backup to enhance its reliability during  
 use.

Referring again to the figures and in particular to FIG. 1 is  
 a perspective view of a pressure assembly 10 comprising a  
 pressurized container or cylinder 12 in fluid communication  
 with an information gauge apparatus 14. The information  
 gauge apparatus 14 includes an input duct 16 (see FIG. 2),  
 such as one provided by a fitting that is rigidly connected to a  
 housing or case 18. The rigid connection between the case and  
 the input duct is possible through fasteners, insert molding, or  
 other approaches appreciated by those of ordinary skill in the  
 art. The gauge housing 18 encases the all of the digital and  
 mechanical components 20 forming a mechanical system 21  
 of the gauge 14 and provides a rigid connection via a groove  
 22 to a gauge face 24, as illustrated in FIGS. 3 and 4. Indicia  
 26 on the gauge face 24 illustrate the various pressure reading  
 of the cylinder or vessel 12. In one example embodiment, the  
 indicia are painted onto the gauge face with florescent and/or  
 luminescent paint.

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The housing 18 includes a removable member 30 on its rear  
 opposite a side of the gauge face or plastic lens 24. The  
 removable member 30 is removably yet rigidly connected to  
 the housing 18 to service an auxiliary power supply 32 to the  
 gauge 14. In one example embodiment, the auxiliary power  
 supply 32 includes conventional batteries. An example of  
 such a rigid connection of the removable member 30 is  
 through the use of fasteners 34, such as screws that engage the  
 housing 18 or through the use of mechanical built in clips on  
 the case or the removable member.

A face seal 36, such as an annular gasket or o-ring provides  
 a water resistant environment relative to removable member  
 30, which is incorporated in the case 18 as illustrated in FIG.  
 5. In one example embodiment, the back plate of case 18 has  
 a plurality openings 25 to allow the free movement of sound  
 waves from a sound chip 27 coupled to a printed circuit board  
 PCB 54 and to prevent over-pressurization in the event of a  
 gas leak.

The case 18 further comprises an ingress resistant material  
 resistant of dust and water. In one example embodiment, a  
 suitable resistant material includes Gore-Tex. In another  
 example embodiment, the gauge face 24 is made from a  
 polymeric material and has mating features to rigidly locate  
 an LCD screen 38 that is part of an electrical system 23. The  
 case 18 in yet another example embodiment is made from a  
 molded polymeric material such as plastic and includes an  
 access panel 31 for the remove and installation of the power  
 cells or batteries 32.

The opposite side of the removable member 30 of the case  
 18 is rigidly connected to a transparent plastics lens 40 for  
 viewing the LCD screen 38 and various visual indicators 42,  
 such as battery indicators, oxygen level indicators, and pres-  
 sure level indicators. The transparent plastic lens 40 may have  
 opaque markings to hide the elements of the gauge 14 that do  
 not provide information to the user for improved aesthetic  
 appearance. The novel input duct 16 is advantageously  
 located in the lower half of the case 18 to provide a direct fluid  
 connection to both the digital system 23 and the mechanical  
 or analog system 21. This enables the novel input duct 16 to  
 be easily machinable and provide two fluid communication  
 connections (a first fluid communication connection 100 and  
 a second fluid communication connection 102) on a distal end  
 44 opposite a proximal or fluid input end 106, as illustrated in  
 FIGS. 21 and 23. The distal end 44 (opposite the pressure  
 vessel or cylinder 12) of the novel input duct 16 allows for  
 fluid communication between the cylinder and the pressure  
 sensor 48 of the digital system 23 and an analog gauge or  
 direct drive gauge 116 of the mechanical system 21 that  
 provide data to user of the gauge 14 relating to parameters  
 (such as time, pressure, flow rate, and the like) of the pressure  
 vessel 12.

Illustrated in the example embodiment of FIG. 17, the  
 digital system 23 is shown, comprising pressure sensor 48,  
 printed circuit board (PCB) 54, LCD 38, power supply 32,  
 microprocessor 56, input/output 58, oscillator 60, sound chip  
 27 or voice chip 52, and various other electronics all in elec-  
 trical communication as would be appreciated by those of  
 ordinary skill in the art. The PCB 54 in the illustrated example  
 embodiment of FIGS. 17, 19, and 22 is supported by bosses  
 110 extending from and molded into the casing 18. The  
 bosses 110 include tapped holes 111 for receiving fasteners  
 112 that only a portion pass through the PCB for securing the  
 PCB into position within the casing 18.

The second fluid communication connection 102 of the  
 input duct provides a pressure sensor 48 port 104 that can be  
 orthogonal to the first fluid communication connection 100.  
 The port 104 is a direct gauge port in order to provide a

relatively small gauge diameter and thickness. In particular, the digital system **23** includes the pressure sensor **48** coupled and in communication with the printed circuit board **54**, while the analog or mechanical system **21** includes a direct drive gauge **116** that is precalibrated and tested prior to installation into the first fluid communication connection **100** port **118**.

In one example embodiment, the direct drive gauge **116** includes a built in feature on the face **120** that allows for install without screws due to the flat surface on the gauge face that enables rotation. This arrangement allows for the smallest possible overall size of the mechanical direct drive gauge **116**. The direct drive gauge **116** is similar to most conventional mechanical gauges that can be purchased as a shelf item and would be a turn-key connection to the input duct **16**.

In an alternative example embodiment, the mechanical system **23** comprises a bordon tube **50** that is connected to a needle **52**. The needle **52** induces pressure on the gauge face **24** based on its markings, similar to a conventional mechanical gauge. The bordon tube **50** in the illustrated example embodiments of FIGS. **10-15** passes through a corresponding manifold tube **46** of the input duct **16**.

Located at an end **122** opposite the analog gauge face **120** is a shaft body **124** (see FIG. **25**) that rigidly connects to the input duct **16**. The shaft body **124** includes a threaded portion **126**, an o-ring **128**, and backup ring **130** that mates with the input duct **16** to allow for a rigid connection **132** and provides a seal-tight engagement connection. A mating flat surface **134** shown on the input duct **16** in one example embodiment is coated with an adhesive, such as Loctite® to prevent rotation of the analog gauge **116**.

The input duct **16** as can be seen in FIGS. **21** and **23** includes a threaded connecting end **150** for coupling to the cylinder **12**. Surrounding the connecting end **150** is a plurality of wrench flats **152** for tightening the gauge information apparatus **14** to the cylinder **12**. A flange **154** is located between the wrench flats **152** and shaft body **124**. The flange **154** is constructed such that it is positioned within the casing **18**, while the wrench flats **152** and threaded connected end project from an opening **156** found in the rear of the casing (see FIG. **22**). The input duct **16** further comprises a single orifice **200** having a pathway **202** that is divided between a first fluid communication channel **100** for coupling to the mechanical gauge **21** and a second fluid communication channel **102** for coupling to the digital gauge **23**.

The input duct **16** and more specifically the flange **154** includes a plurality of tapped holes **158** for the attachment of fasteners **160**. The fasteners pass partially through the back of the casing **18** into the tapped holes **158** surrounding the flange **154**. In one example embodiment, the input duct is made from metal, such as stainless steel or brass.

Referring again to the digital system **23**, the pressure sensor **48** communicates with a PCB (Printed Circuit Board) assembly **54** that comprises a microprocessor **56**, I/Os **58**, oscillator **60**, voice chip **62**, and electronics **64**, that include capacitors, resistors, transistors and other connectors. The electronic **64** connectors couple the PCB **54** to a battery pack **32** that provides power and to the LCD **38** (which is also coupled to the PCB) screen that displays information such as pressure, time remaining in minutes and the battery level. The pressure sensor **48** includes a number of contacts or terminals **162** that act as leads and are soldered or wired to the PCB **54** or to other portions of the digital system **23** as would be appreciated by one of ordinary skill in the art.

A full pressure (2016 psi) E size aluminum cylinder **12** has 679 liters and thus other values can be interpolated from this information. The microprocessor **56** obtains the differential pressure information from the pressure sensor **48** by sampling

between 2 periods, which indicates the flow. For example, a loss of about 6 psi, in one minute equates to a flow of about 2 Liters per minute, which is computed by the microprocessor **56** and displayed in one example embodiment on the LCD screen **38**. The microprocessor **56** also senses the overall pressure in the pressure vessel **12** through the pressure sensor **48**, which is then by the microprocessor converted to total volume in liters.

During operation in one example embodiment, a full cylinder **12** could hold 679/liters, which is divided by 2 liters per minute by the microprocessor **56**, which executes instructions in the form of non-transitory computer readable medium **57** that includes for example software, firmware, application specific analog circuit, or any combinations thereof hereinafter “recipe” that computes a result **59** that in this example is 339 minutes and 30 seconds of available time before the cylinder coupled to the gauge **14** becomes empty. One of the outputs **58** from the PCB assembly **54** is connected to the LCD screen **38** that is able to display alpha-numeric characters of the result **59**.

In one example embodiment, the LCD screen **38** is in the same plane as the gauge face **24**, which displays time remaining before the vessel **12** is depleted of gas, amount of pressure in the vessel **12**, and the status of the remaining power in the battery **32**. In the illustrated example embodiment, the power supply **32** comprises a dual power source of first and second power cells **32A**, **32B**, respectively such as batteries that supply power to the electrical system **23**. In yet another example embodiment, the power cells **32A** and **32B** are coupled in parallel to the PCB **54** such that one power cell acts as a backup to the other should the power die or become low in either of the cells.

The PCB board **54** in one example embodiment provides a connection **136** to one end **65** of a membrane switch **43**. Another end **67** of the membrane switch **43** is rigidly glued to the plastic lens **40**, as illustrated in FIGS. **16** and **26**. This membrane switch **43** has three LEDs **138** and a button **45** that can mute the voice chip **62** or power off the electronics and electrical system **23** by holding down a button or switch **45** for a long period of time (example 4 secs). The voice chip **62** provides audible information such as “Low Gas” when the pressure in the cylinder is inadequate for function. Through the membrane switch **43** the customer can view visual information indicating red (low pressure), Yellow (change battery), or Green (adequate pressure) lights through LEDs **138**.

In the illustrated example embodiment, the membrane switch **43** is located on or near indicators **42** and provides a user interface for adjusting various settings on the gauge **14**. In one example embodiment, the membrane switch **43** is in communication the PCB **54** and receives its power from the batteries **32**. The membrane switch **43** includes in one example embodiment a switch **45** for pausing or halting the operation of the PCB **54** for putting the gauge **14** in sleep mode to conserve battery **32** life, various resets, and the like. In the illustrated example embodiment, the membrane **43** switch also includes a plurality of LEDs **47/138**, providing status indicators (battery low, LOW O<sub>2</sub>, and system OK) to a user that is viewable on the front of the gauge face **24**. The location of the membrane switch **43** provides a robust construction that is protected by the gauge face **24**.

The PCB assembly **54** is also programmed with logic that enables it to conserve battery life. By sensing if there is a reduction in pressure through the pressure sensor **48**, the PCB assembly can determine if the unit **10** is being used. If there is no reduction in pressure, which implies the unit **10** is not being used, the PCB assembly **54** can activate a sleep mode **70**. The sleep mode **70** will increase the duration between

pulses, decrease the length of the LED pulse and also increase the frequency of sample from the pressure sensor 48, thus consuming less power. The PCB assembly 54 may also signal the LCD 38 to be blank in the sleep mode.

In one example embodiment, the gauge apparatus 14 provides an estimated time remaining that is dynamically updated to the face gauge 24 according to the chosen flow setting in a valve (not shown) located between the gauge 14 and vessel 12. In another example embodiment, the gauge 14 provides an audio visual warning, affording users of the unit 10 with confidence required to use the product as a multi-use system and warns the users when the gas level or pressure is low, thus improving efficiency and safety.

While yet another advantage of the gauge apparatus 14 is provided the mechanical system 21 acting as a analog or mechanical backup 72 formed by the novel input duct 16 that is rigidly connected to a custom but conventional direct drive gauge 116 with readings in case of failure to the pressure sensor 48. This is especially advantageous over solely digital designs that are susceptible to errors or inaccurate readings when near equipment producing magnetic fields, such as MRI equipment. The gauge apparatus 14 significantly reduces such errors due to this secondary analog backup system 72 of the present disclosure. Moreover, the mechanical backup system 72 improves the likelihood of approval of the FDA over fully digital systems because of the shortcomings discussed above.

In the illustrated example embodiment, the overall design and construction of the batteries 32, PCB 54, and sensor 48 are advantageously such to provide a very compact information gauge 14. In particular, the current construction is approximately one-inch thick (t) and two inches in diameter (D). Of course it should be appreciated that larger sizes of the gauge apparatus 14 are possible and within the spirit and scope of the present disclosure.

Yet another advantage of this example embodiment is the membrane switch 43, which enables the user to advantageously confirm the flow for fast accurate feedback. While a conventional gauge is capable of generating time to empty information relating to the vessel in which the gauge is being used, the conventional gauge does require a steady flowing state, which may take several minutes to occur if the flow rates are changed by a flow control (for example, from max to min) due to the inherent system dynamics. To avoid the long time delay experienced by users in conventional systems, users of the present gauge 14 have the option of selecting a flow setting by pressing the membrane switch 43, which toggles between various pre-set flow settings viewable in the LCD screen 38. The user therefore can select the matching flow setting administered to the patient that then results in immediate and accurate time to empty information. In this way, the user is able to verify if the time remaining is satisfactory before moving on to the next patient, which enhances safety through double-checking.

In the foregoing specification, specific embodiments have been described. However, one of ordinary skill in the art appreciates that various modifications and changes can be made without departing from the scope of the disclosure as set forth in the claims below. Accordingly, the specification and figures are to be regarded in an illustrative rather than a restrictive sense, and all such modifications are intended to be included within the scope of present teachings.

The benefits, advantages, solutions to problems, and any element(s) that may cause any benefit, advantage, or solution to occur or become more pronounced are not to be construed as a critical, required, or essential features or elements of any or all the claims. The disclosure is defined solely by the

appended claims including any amendments made during the pendency of this application and all equivalents of those claims as issued.

Moreover in this document, relational terms such as first and second, top and bottom, and the like may be used solely to distinguish one entity or action from another entity or action without necessarily requiring or implying any actual such relationship or order between such entities or actions. The terms “comprises,” “comprising,” “has”, “having,” “includes”, “including,” “contains”, “containing” or any other variation thereof, are intended to cover a non-exclusive inclusion, such that a process, method, article, or apparatus that comprises, has, includes, contains a list of elements does not include only those elements but may include other elements not expressly listed or inherent to such process, method, article, or apparatus. An element preceded by “comprises . . . a”, “has . . . a”, “includes . . . a”, “contains . . . a” does not, without more constraints, preclude the existence of additional identical elements in the process, method, article, or apparatus that comprises, has, includes, contains the element. The terms “a” and “an” are defined as one or more unless explicitly stated otherwise herein. The terms “substantially”, “essentially”, “approximately”, “about” or any other version thereof, are defined as being close to as understood by one of ordinary skill in the art. In one non-limiting embodiment the terms are defined to be within for example 10%, in another possible embodiment within 5%, in another possible embodiment within 1%, and in another possible embodiment within 0.5%. The term “coupled” as used herein is defined as connected or in contact either temporarily or permanently, although not necessarily directly and not necessarily mechanically. A device or structure that is “configured” in a certain way is configured in at least that way, but may also be configured in ways that are not listed.

To the extent that the materials for any of the foregoing embodiments or components thereof are not specified, it is to be appreciated that suitable materials would be known by one of ordinary skill in the art for the intended purposes.

The Abstract of the Disclosure is provided to allow the reader to quickly ascertain the nature of the technical disclosure. It is submitted with the understanding that it will not be used to interpret or limit the scope or meaning of the claims. In addition, in the foregoing Detailed Description, it can be seen that various features are grouped together in various embodiments for the purpose of streamlining the disclosure. This method of disclosure is not to be interpreted as reflecting an intention that the claimed embodiments require more features than are expressly recited in each claim. Rather, as the following claims reflect, inventive subject matter lies in less than all features of a single disclosed embodiment. Thus the following claims are hereby incorporated into the Detailed Description, with each claim standing on its own as a separately claimed subject matter.

What is claimed is:

1. An information gauge apparatus for displaying information relating to diagnostics when said information gauge apparatus is coupled to a pressure vessel, the apparatus comprising:

a digital gauge having a digital display, printed circuit board, and pressure sensor, the digital display being coupled to and in communication with said printed circuit board that is further coupled to and in communication with said pressure sensor, the digital display illustrating pressure conditions relating a pressure vessel when in use;

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a mechanical gauge providing a mechanically sensed pressure conditions relating to a pressure vessel when in use; a casing for supporting said mechanical gauge and said digital gauge having a back plate and a front plate; and an input duct for coupling said digital gauge and said mechanical gauge to a pressure vessel during use, the input duct having a single orifice for coupling to a pressure vessel, the single orifice having a pathway that is divided between a first fluid communication channel for coupling to said mechanical gauge and a second fluid communication channel for coupling to said digital gauge.

2. The apparatus of claim 1, wherein said digital display further comprises an liquid crystal display (LCD) with an indicator for displaying the relative strength of a power supply located within said casing.

3. The apparatus of claim 1 wherein said casing is secured to the input duct, the casing further comprising bosses for rigidly locating said printed circuit board.

4. The apparatus of claim 1, wherein said printed circuit board further comprises a wireless transmitter for transmitting pressure information about a pressure vessel when in use.

5. The apparatus of claim 1, wherein said digital gauge further comprises a membrane switch for powering down the digital gauge, muting the voice alarm and selecting a preset flow.

6. The apparatus of claim 1, wherein said digital gauge further comprises an audible signal relating to the conditions sensed by said digital gauge pressure sensor.

7. The apparatus of claim 1, wherein said digital gauge further comprises an audible signal relating and a visual display, both relating to the pressure and remaining time before pressure reaches atmospheric pressure in a pressure vessel during use and said mechanical gauge providing a nonelectrical powered visual display as to the pressure in said pressure vessel during use.

8. The apparatus of claim 1, wherein said input duct comprises a flange for attaching said flange portion within and to said casing such that a portion of said input duct is positioned within said casing during use.

9. The apparatus of claim 1, wherein said mechanical gauge face that has a flat that enables assembly to said input duct without fasteners.

10. The apparatus of claim 5, wherein said membrane switch is rigidly connected to a plastic lens, the membrane switch having an input button.

11. An information gauge apparatus for providing both visual and audio readings of pressure within a pressure vessel, the information gauge apparatus comprising:

a digital display coupled to a printed circuit board in communication with a pressure sensor, the digital display illustrating indicia relating gas pressure levels provided by said pressure sensor to said printed circuit board during use;

an audible indicator coupled to said printed circuit board, the audible indicator providing an audible signal relating to gas pressure levels provided by said pressure sensor to said printed circuit board during use;

a mechanical sensor providing a mechanically sensed reading value to a visual indicia display on said information gauge apparatus relating to gas pressure levels during use; and

an input duct for coupling said digital display and said mechanical sensor to a pressure vessel during use, the input duct having a single orifice for coupling to a pressure vessel, the single orifice having a pathway that is divided between a first fluid communication channel for

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coupling to said mechanical sensor and a second fluid communication channel for coupling to said digital display.

12. The apparatus of claim 11 wherein said input duct further comprises an electronic pressure sensor coupled to said duct in said second fluid communication channel and in communication with said digital display.

13. The apparatus of claim 12 further comprising a printed circuit board for coupling in communication said digital display with said electronic pressure sensor.

14. The apparatus of claim 11 wherein said first and second fluid communication channels comprise a tapped opening in fluid communication with said single orifice, the tapped openings for receiving a threaded end of said pressure sensor in said second fluid communication channel and a thread end of said mechanical sensor in said first fluid communication channel.

15. The apparatus of claim 14 wherein said mechanical sensor further comprises an analog gauge with a gauge face comprising indicia indicating the pressure of the pressure vessel during use, the indicia having at least one of florescent and luminescent paint.

16. A digital audio visual information gauge with a mechanical pressure indicating backup, said gauge comprising:

a casing that provides a housing for a mechanical system and an electrical system, the electrical system is capable of indicating time and pressure remaining in a cylinder valve assembly during use and the mechanical system being capable of indicate pressure remaining in the same cylinder valve during use;

an input duct that is rigidly connected to said casing, the input duct having a single orifice for connecting to a cylinder valve at a first end of said input duct and first and second fluid communication channels at a second end of said input duct, said first and second fluid communication channels being in communication with said single orifice, the first fluid communication channel for coupling to said mechanical system and said second communication channel for coupling to said electrical system.

17. The gauge of claim 16 further comprise a removable member that is serviceably connected to the case, said case further incorporating a face seal that is contact with the removable member, said case further comprising openings for the passing of sound waves from a sound chip of said electrical system.

18. The apparatus in claim 1 where the PCB has a dual power source that is rigidly attached to either side of the PCB.

19. The gauge of claim 16 wherein said mechanical system further comprises an analog gauge.

20. The gauge of claim 19 wherein said analog gauge further comprise a bordon tube for passage coupling to said input duct and said electrical system comprises a pressure sensor for coupling to said input duct.

21. An information gauge apparatus for coupling to a pressure vessel during use, the apparatus comprising:

a digital gauge having a digital display and pressure sensor, the digital display being coupled to and in communication with said pressure sensor, the digital display illustrating pressure conditions relating a pressure vessel when in use;

a mechanical gauge measuring and displaying a mechanically sensed pressure conditions relating to a pressure vessel when in use;

a casing for supporting said mechanical gauge and said digital gauge having a back plate and a front plate

a lens that is located on the casing for viewing said mechanical gauge and said digital gauge; and an input duct for coupling said digital gauge and said mechanical gauge to a pressure vessel during use.

22. The apparatus in claim 1 further comprising a micro-processor for initiating a sleep mode condition of said apparatus for conserving power of a power supply located within said casing. 5

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